MARCH 1960
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CANADIAN ELECTRONICS ENGINEERING

SPECIAL REVIEW OF OSCILLOSCOPES

AND SIGNAL GENERATORS

MAR 28 1960

new products review

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March, 1960

CANADIAN ELECTRONICS ENGINEERING

Volume four, number 3

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cover design

Art director Frank Davies has utilized his skill with type to create an unusual and interesting illusion of signal generators and cathode ray oscilloscopes.

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authors and articles in this issue:

The theme of this issue of CEE is new products, with emphasis on cathode ray oscilloscopes and signal generators. With the help of three experienced engineers, who are well qualified to bring the latest news in their respective fields, and also with the help of many other industry members, the editors of CEE have been able to assemble information that should be of great help in keeping up to date with new developments.

The tables listing CRO's and signal generators are not intended to be all-inclusive. They will, however, provide a starting point in your search for the instrument you need to fill your requirement.

After you have used the tables to narrow down your possible selection, contact the sales representatives and get complete information from them.

M. B. Crouch (New techniques extend bandwidth of cathode ray oscilloscopes) was born in Markham, Ontario, but moved to Portland, Oregon with his family. In 1954 he graduated from Oregon State College with a degree in electrical engineering. The same year he moved to Ottawa where he served as a patent examiner with the Canadian Government.

Crouch

In 1956 Mr. Crouch joined Tektronix, Inc. as a field engineer and opened their Toronto office in 1957. He is a member of the Association of Professional Engineers of Ontario, a member of the Institute of Radio Engineers and a member of the American Institute of Electrical Engineers.

Two engineers from General Radio Company, Cambridge, Mass. wrote the paper Design trends increase versatility of standard signal generators.

W. F. Byers graduated from Ohio University with a degree of Bachelor of Science in electrical engineering, 1943. After one term of teaching a course in electrical engineering at Ohio University, he joined General Radio Company. During the war Mr. Byers was engaged in the development of special purpose signal generators. Since then he has been engaged in the development of standard signal generators and related equipment, in addition to doing part of the development of frequency modulation and television broadcast monitoring equipment. He is a member of the Institute of Radio Engineers.

Byers

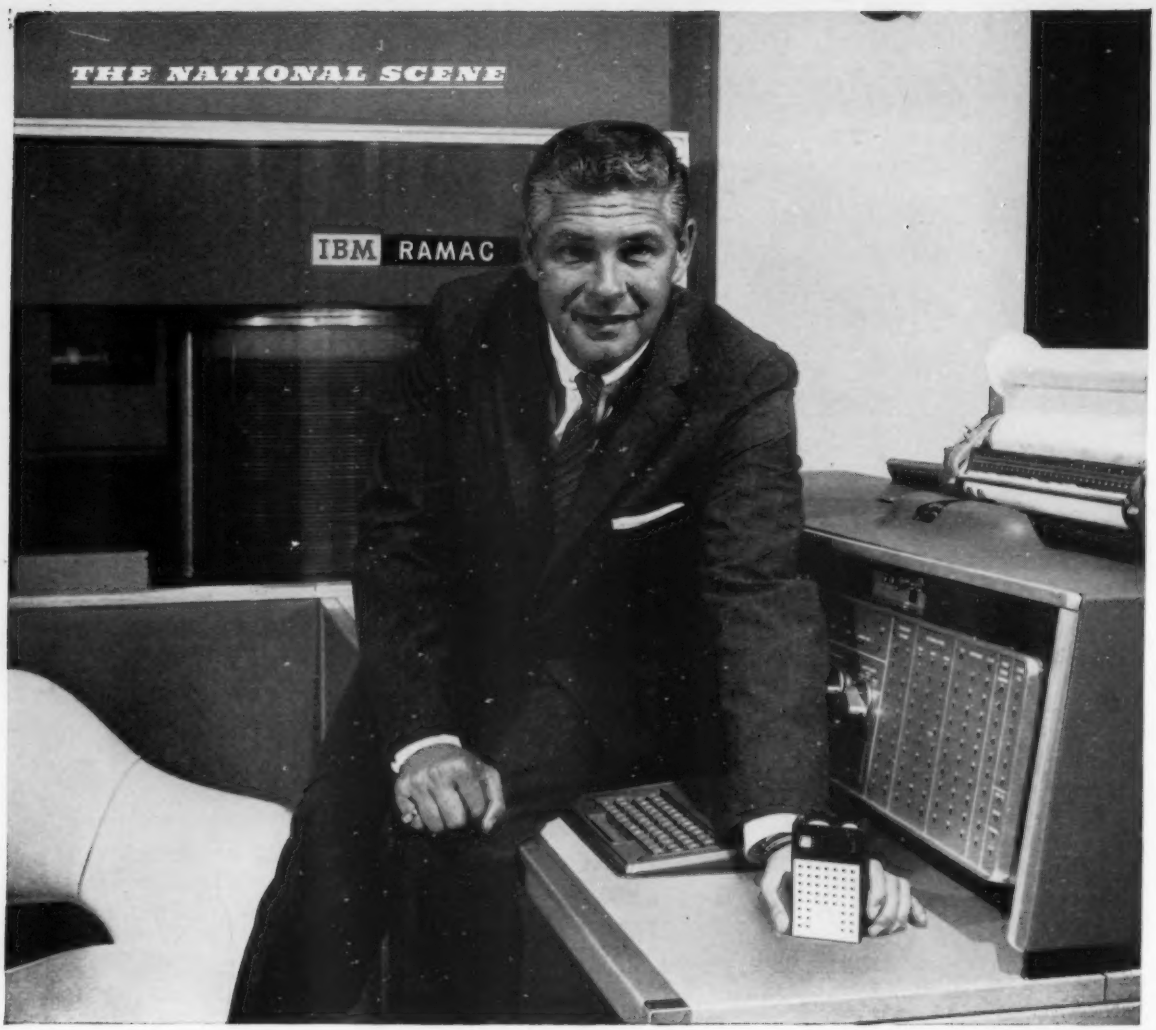
McCouch

Gordon P. McCouch was born in London, England and graduated from Harvard University with an A.B. degree, cum laude, in 1941. He obtained his M.A. degree in 1948.

In 1942 Mr. McCouch joined the Radio Research Laboratory and worked in the radar countermeasures field. In the same year he went to England for the Office of Scientific Research and Development where he did liaison work with the Telecommunications Research Establishment (RAF), and installed the first radar countermeasures equipment used by the U.S. 8th Bomber Command. Later he worked on vhf and microwave relay communications circuits in Europe. He was awarded the Army-Navy Certificate of Appreciation.

In 1945 Mr. McCouch joined the staff of Aircraft Radio Corp., then spent 1948 as a Teaching Fellow at Harvard University. Since 1957 he has been with the engineering department of General Radio Company.

Mr. McCouch is a senior member of the Institute of Radio Engineers and is currently treasurer of the Boston Section.



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NEWS HIGHLIGHTS

Defence Research Board has unveiled a model of its satellite for research of the ionosphere. United States will launch it in November, 1961.

Scientists at Defence Research Board have released pictures of a model of the satellite they are building under a joint project with the U. S. National Aeronautics and Space Adminstration. The satellite, shaped like a washing machine, will study upper regions of the ionosphere and work in conjunction with ground stations studying the under side of this layer of charged particles. The satellite will be launched from California in an 80-degree orbit.

Radio communications between Hawaii and Washington, D.C., will use the moon as a reflector. Five to seven hours' service per day is predicted.

The U. S. Navy Department is about to place its new Washington-Hawaii 'moon bounce' communications circuit into operation. Signals will be bounced off the surface of the moon during the five to seven hours when the moon is visible to both sites.

Canada will help build a telephone cable joining Vancouver with New Zealand and Australia. This will be a link in global telephone system.

Subject to completion of other agreements, Canada is going to contribute $25,000,000 towards construction of the Pacific cable. This will be the second leg of an around-the-world telephone system, and will be laid from Vancouver to New Zealand and Australia, providing 80 voice channels. Target date for completion of the $75,000,000 Pacific cable is 1964.

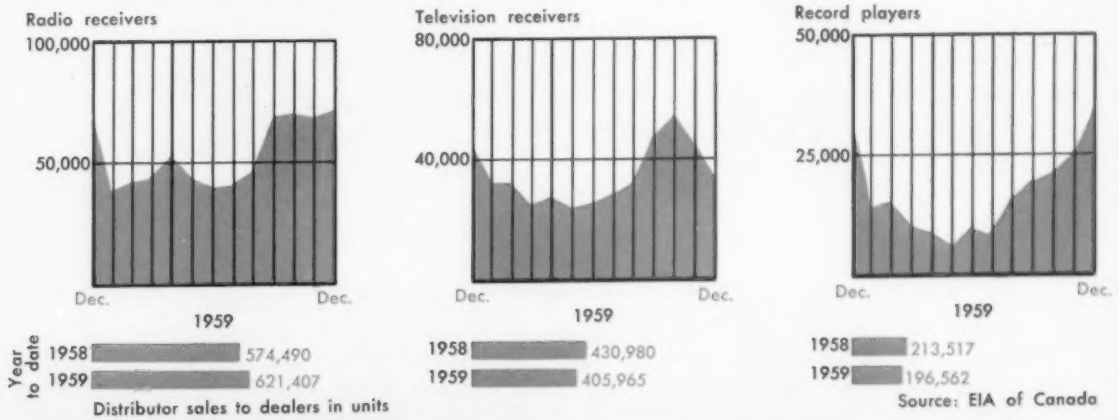
The Federal Government has cut its budget. Estimates for defense were reduced by about six percent.

The Canadian Government is trying to balance its budget this year by cutting controllable expenditures. Defence spending will be $1,593,272,266 — a drop of $86,921,740 from initial estimates. This will be the smallest defence program since the defence buildup began in 1950, and most of the savings will come from reduced procurement of new equipment.

The U. S. electronics industry faces a quandary over the sharp rise in imports of transistors from Japan.

The U. S. electronics industry appears to have used too much positive feedback in its transistor deals and wound up with a lot of howling. Through direct and indirect financial arrangements with Japanese firms, U. S. companies have helped build up transistor manufacturing in that country. Now the U. S. Electronics Industry Association is alarmed by the rapid jump in imports, and is trying to throw up some barriers. IBM took a positive approach: it imported the inventor of the tunnel diode.

Radio sales up 8% over 1958; tv down 6%, record players 8%



THE AGE OF TOTAL COMMUNICATIONS!

It's barely a half-Century since the human voice was transmitted over distance for the first time. Eleven years later — 1919 — the first Canadian radio station commenced regular transmissions to a few enthusiasts operating home-made crystal sets.

From this one-station start grew a communications giant which now boasts more than two hundred radio stations and a potential audience which encompasses the total population of Canada!

Then to, the growth of television has been even more spectacular!

By the latest count fifty-six stations now transmit daily to an audience in excess of fourteen million Canadians!

As that first recorded transmission between Rome and Sicily in 1908 paved the way to total communications in Canada, so has Standard Telephones and Cables contributed equally . . .

STC have designed, manufactured and installed communications links . . . radio, television, telephone and telegraph . . . in fifty-seven countries — including more than a thousand miles of television-telephone microwave links in Canada!

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American companies reorganize Canadian operations

McGraw-Edison forms Canadian corporation

McGraw - Edison (Canada) Ltd., with headquarters in Toronto, has been formed to act as an entirely Canadian operated corporation. There will be three divisions which previously operated as subsidiaries to their respective parent companies in the U. S. They include Thomas A. Edison Industries, Toronto, (formerly Thomas A. Edison of Canada Ltd.) makers of dictating equipment; CLM Industries, Scarborough, Ont., (formerly Canadian Line Materials Ltd.) electrical transmission and distributing equipment; and the Small Appliance Division, Oakville, Ont., makers of power tools, hair dryers and clippers.

George Axson, Toronto, formerly treasurer of Canadian Line Materials Ltd., has been appointed vice-president and treasurer of McGraw-Edison (Canada) Ltd. Other officers for Canada include: president, **Alfred Bersted,** Elgin, Illinois; Controller, **R. W. Martin,** Chicago; and secretary, **Judson Large,** Chicago.

Additional appointments announced include **J. R. Lister,** Toronto, former general manager, who now becomes division president of Thomas A. Edison Industries. **Thomas G. Quance,** Toronto, previously assistant to the president of Canadian Line Materials Ltd., will now act as division president of both the newly formed CLM Industries and the Small Appliance Division.

Centralab appoints Canadian general manager

In a reorganization to keep pace with changing conditions in Canada, Centralab Canada Ltd. will have **Peter J. Heenan** as general manager. He formerly held the position of sales manager.

J. F. Brooks, who has been plant manager for the past eight years, has been appointed manager of manufacturing in Centralab Canada Ltd.'s new facilities located on McMaster Ave., Ajax, Ont.

RAPID GRIP & BATTEN

Houlding

Heenan

Elected RCA Victor president

John D. Houlding, formerly vice-president and general manager, has been elected president of RCA Victor Co. Ltd. **P. J. Casella,** formerly president, and recently appointed to the position of executive vice-president, consumer products, Radio Corporation of America, continues as a director of the company and chairman of the executive committee.

Born in London, Ont., Mr. Houlding was educated at the University of Western Ontario. He served as radar officer on loan to the Royal Navy from 1943 to 1945. He was also on loan to the Department of Defence Production in 1952. Mr. Houlding first joined RCA Victor in 1957 as vice-president in charge of technical products. In 1958 he was elected a director of the company.

Executives for Sola Electric

The board of directors of Sola Electric (Canada) Ltd. has announced election of **J. R. McGovern** as vice-president and general manager of the company, and his re-election to the board. He is currently in charge of operations at the Sola plant, 24 Canmotor Ave., Toronto, and will also be in charge of a new plant to be opened within several weeks at 377 Evans Ave., Toronto. The company is a wholly owned subsidiary of Basic Products Corp., Milwaukee.

John R. Fischer, Chicago, was elected chairman of the board of Sola Electric (Canada) Ltd. Other directors elected to the board were **L. B. Lattin, D. G. Seay** and **W. W. Mason,** all of Milwaukee. Mr. Lattin was also named vice-president and chief executive officer of Sola Electric (Canada) Ltd. **A. W. Drigot,** Milwaukee, was elected secretary and treasurer, and **H. Mortimer,** Chicago, was elected controller of the Canadian company.

Appointments at Avro

Kenneth W. Brown has been appointed to the position of vice-president and general manager of Avro Aircraft Ltd. **John L. Plant** has been appointed vice-president and general manager of Canadian Applied Research Ltd., and **Burton A. Avery** has been appointed vice-president and general manager of Orenda Engines Ltd. The three companies are members of the aeronautical group of A. V. Roe Canada Ltd. Harvey R. Smith remains chairman and president of the three companies.

TV and radio sales manager

The appointment of **N. A. Fallow** as sales manager of the broadcast and television receiver division, Canadian Marconi Co. has been announced by Mr. Kelly, division manager. Mr. Fallow was formerly sales manager of Emerson Radio of Canada Ltd.

Axson

Bersted

Lister

Quance

CRONAFLEX*

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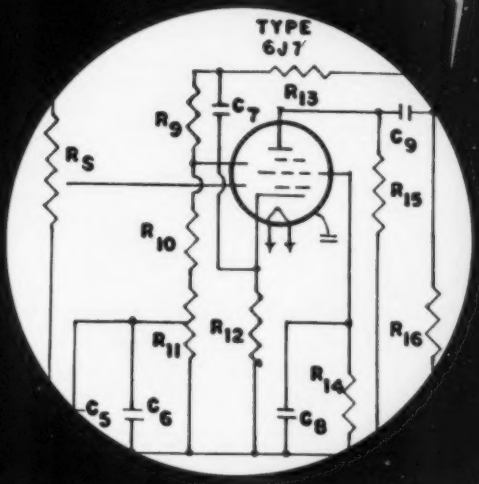

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De Havilland Aircraft of Canada increases commercial activities

The board of directors of the de Havilland Aircraft of Canada, Ltd., has announced that the name of the company's Guided Missiles Div. is changed to the Special Products Division. The new name reflects a changed emphasis in the activities of the division. The company intends to achieve diversification into the non-defense field, while continuing to provide specialized equipment for defense requirements.

Major activities of the new division are presently concentrated in the field of infrared systems, static transistorized power supplies, thermionic and other advanced power developments, instrumentation, pneumatic, hydraulic and electrical control systems.

ATC opens new plant in Canada

Because of the rapidly increasing demand in Canada for completely automatic control of manufacturing and processing operations, Automatic Timing & Controls division of Interprovincial Safety Industries, Ltd. has established a manufacturing plant at 5485 Notre Dame St. West., Montreal, with continent-wide sales and service facilities.

The new Canadian division is under the management of James Cullen, who will also continue as manager of Interprovincial Safety Industries, Ltd. The Toronto area will be served by Lisle Instruments Systems, 767 Warden Avenue, Scarborough, Ontario, headed by Ray E. Green and Tom Lisle. The Montreal area will be served by Associated Instrumentation and Controls, Ltd., 2655 Bates Road, Montreal, headed by Joseph H. Amblard and Edward Rogers.

The expanded Canadian sales organization will include sales and service representation in Edmonton, Vancouver, Winnipeg and Calgary. The instrument repair work will be carried on by R. C. Ward Co. of Toronto. Mr. Ward, factory-trained in the ATC headquarters plant, will carry a full line of factory parts in stock, and will perform both field services and instrument repair work.

Training starts for CADIN operators

Eight men have been training at Burroughs Adding Machine of Canada Ltd., Toronto to act as instructors for 200 other men scheduled for duty at the CADIN stations. The first class of 20 men is scheduled to start this month on the 22-week course. Applicants are being selected from among Canadians who have had previous radar or communications training, or are graduates of technical trade schools.

CADIN (Canadian Air Defence Integration North) is the Canadian equivalent of the SAGE (Semi-Automatic Ground Environment) used in the United States.

Primary responsibility of the technicians will be to install and maintain the Burroughs-built CADIN electronic data processing system.

Change of address

The Glendon Instrument Co. Ltd., manufacturers' representatives, are now at 46 Crockford Blvd., Scarborough, Ont. Telephone: PLymouth 9-6021.

Representatives of nearly 70 Canadian electronics and allied manufacturers met with 13 members of the purchasing, engineering, and quality control staffs of the Defense Electronics Division, General Electric Company, when GE held a Purchasing Seminar in Toronto recently. GE's requirements were related to Canadian facilities during across-the-table discussions, and it is expected that an increase in Production Sharing orders will result from the contacts made.

Ottawa report

Prime Minister Diefenbaker was at some pains in announcing plans for a parliamentary committee on defence to point out that it should not try to propose a new defence policy for Canada. That's the government's responsibility, he said.

Perhaps the committee won't propose any formal new policy, but it would be naive to think that defence policy won't be the main point of interest for committee members.

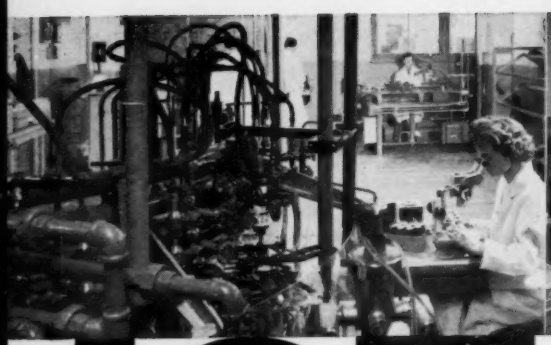
"It certainly could discuss policy," Opposition Leader Pearson said in one Commons exchange with the Prime Minister on the question. If it were set up for this purpose, "it could bring in recommendations, get advice on policy and ask the defence minister about policy questions."

He pointed out that this is already done by the House committee on external affairs. But he further pointed out that he was not suggesting the committee should question any officials —anyone but the minister responsible—on matters of policy.

The tradition that government officials save their advice and opinions only for the private ears of the cabinet ministers who must bear the final responsibility for all policy is one, said Mr. Pearson, "we would not wish to see broken before any committee."

Hazen Argue, CCF House Leader, said the committee should not only examine defence expenditures but defence policy, too, with a view to arriving at the best possible one.

"There is not much use in enquiring into the mistakes which have been made in the past," he said, "if the committee can't express its views as to what course should be followed in future."



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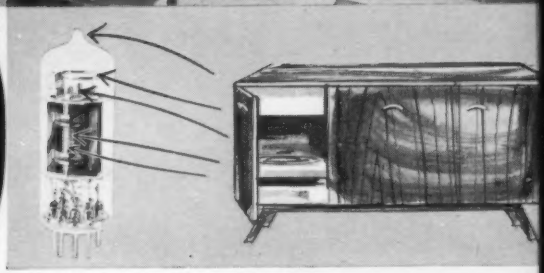

A YEAR OF PROGRESS AT C.G.E. IN DESIGN, DEVELOPMENT, PRODUCTION OF ELECTRONIC TUBES AND SEMICONDUCTORS

Progress at Canadian General Electric in 1959 meant more than maintaining position as the leading Canadian manufacturer of electronic tubes and semiconductor products.

It included expanded research facilities for designing and developing new types to meet the special demands of Canada's fast growing electronics industry. New design features were incorporated in many existing types to achieve improved performance.

New manufacturing methods and more efficient equipment were combined in 1959 to provide you with products that are superior in every respect . . . at the lowest possible price.

As in 1959, progress gets top priority at C.G.E. in 1960. New products are already on the planning board and engineering research continues to look for ways to improve present products. And to meet your immediate needs, C.G.E. is the one source you can depend on to completely fill your electronic tube and semiconductor requirements.

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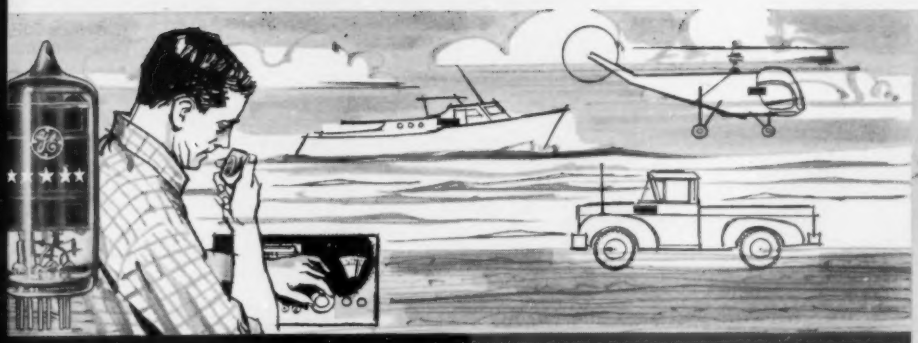
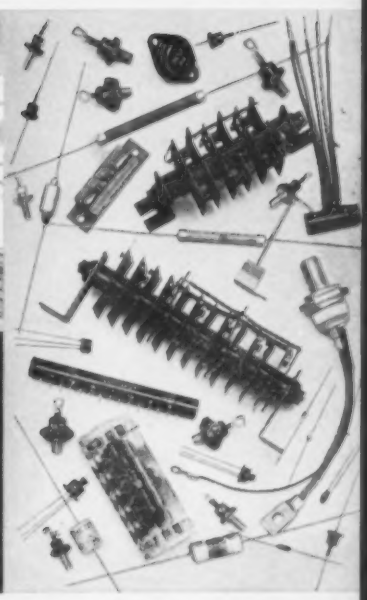
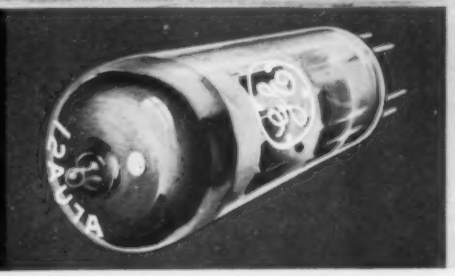






New Design Engineering Lab.

The only one of its kind in Canada, C-G-E's design engineering lab was greatly expanded in 1959. It was given completely new and separate facilities and its own highly specialized production equipment. This enabled research and development programmes to be carried out without interruptions. The result was, new advancements were achieved faster, and many new or improved products were made available to you sooner.

New Tubes For Every Application.

The success of C-G-E's accelerated research efforts is reflected in the number of new tube types that rolled off the production line by the end of 1959. C.G.E. produced 17 new entertainment type tubes, including such advanced types as the 7025A.

The results for industrial and military tubes were equally impressive. 10 new types of high-reliability G-E 5-Star receiving tubes were added to production. In addition this included the specially developed 6J4WB. MIL approval was obtained on 16 types. Three new transmitting tubes were also developed for critical military and industrial application.

In picture tubes, the development and production of the revolutionary new 23" picture tube by C.G.E. was hailed by the entire industry as a notable achievement. New, short, short neck picture tubes were also designed and produced, such as the 17DTP4 and the 21DLP4.

New Design Features

In 1959 C.G.E. incorporated many fully developed and thoroughly tested design improvement features into G-E tubes. These features increased the already high standards set by C.G.E. for reliability and performance. FORMED TIPS to reduce breakage and eliminate handling injuries. New HALO GETTER to prevent early failures due to cathode poisoning. CATAPHORETICALLY COATED HEATER BENDS to prevent heater-to-cathode shorts and leakage. FLIPPER MICAS to hold the cathode rigid—eliminating microphonics. TOP BRANDING and PIN LOCATOR DOT for quick identification and faster installation.

Superior performance from all G-E Black-Daylite picture tubes was obtained through new gun design. The new gun improved beam centering and resolution.

Semiconductor production greatly expanded.

Early in 1959 C.G.E. embarked on an extensive semiconductor development and manufacturing programme. Production of germanium and silicon stacked rectifiers was started, making available over 750 different combinations; 70 new glass encased germanium and silicon diodes were made available. Over 105 new germanium and silicon type rectifier cells were developed. In addition MIL approval was obtained on many new types.

To provide you with better service and to meet growing demands, C.G.E. expanded its sales engineering organization and enlarged semiconductor application engineering facilities.

Progress Is Our Most Important Product

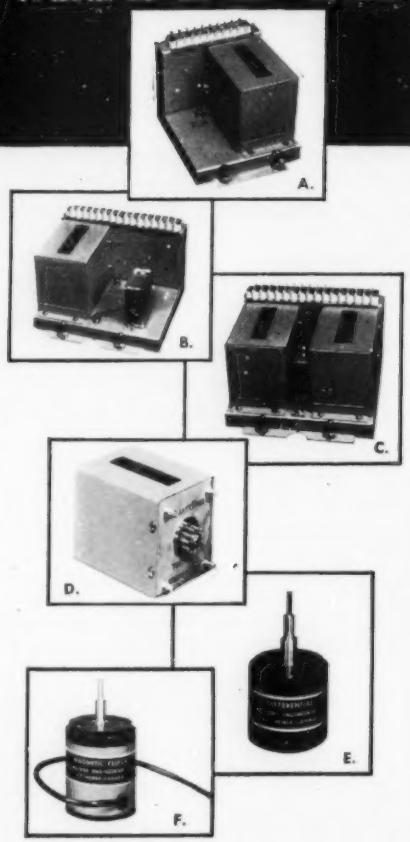
GENERAL ELECTRIC
ELECTRONIC TUBES
SEMICONDUCTORS

ELECTRONIC TUBE SECTION
CANADIAN GENERAL ELECTRIC COMPANY LIMITED

A good name in SERVO SYSTEMS and COMPONENTS is MARSLAND

This precision electro-mechanical-optical computer, used to display the geographical position of a ship and its target satellites, is a current system design by Marsland. From a statement of requirement to a design concept, to a working prototype and to approved production assemblies, Marsland engineers servo-systems meeting the most rigid specifications.

Wide experience and comprehensive facilities enable Marsland to manufacture most of the various system components.



A. Transistor Servo Amplifier, Mod. AM-103. *Application:* Single channel, 400 c. synchronous positioning servo loop. Up to size 18 Bu. Ord. motor, with built-in 400 c. power supply and feed-back damping control.

B. Transistor Servo Amplifier, Mod. AM-102. *Application:* Two channels, 400 c. precision positioning servo loop, (i.e. Resolver). Up to size 18 Bu. Ord. motor, built-in 400 c. power supply, transfer input network, feed-back damping and stick-off voltage controls.

C. Transistor Servo Amplifier, Mod. AM-101 (AM-104 + AM-105). *Application:* High gain, 400 c. synchronous amplifier for highest accuracy velocity integrating servo-loop, using up to size 18 Bu. Ord. motor/tachometer generator. *Built-in:* power supplies, null voltage suppressor, tachometer generator phasing network, speed adjustment and quadrature rejection circuit.

D. Transistor Amplifier, (Pre-Amplifier) Mod. AM-104. *Class A*, all transistor voltage and low power amplifier combined. Voltage gain between rated impedances is adjustable between 50 and 150 V. Built-in power supply, 400 c. (Power Amplifier AM-105 packages in same manner: *Class B*, all transistor synchronous power amplifier-application as positioning and integrating servo amplifier.)

E. Differential, Model M-134. *Body and Mounting:* Similar to size 18 Bu. Ord. motor. All ball bearings. *Application:* Servo mechanisms and computors. *Speed/Torque:* symmetrical mechanical differential max. speed of any shaft 4000 r.p.m.; max. torque output 10 oz. inch.

F. Magnetic Clutch, Model M-133. *Body and Mounting:* Similar to size 18 Bu. Ord. motor. All ball bearings. Max. speed 4000 r.p.m. *Application:* Servo mechanisms and computors. Energizing Power: 24 V.D.C., 3 watts. *Min. Torque:* 35 oz. inch.

MARSLAND ENGINEERING LIMITED

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M/3

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in TELETYPE TRANSMISSION

The Telesignal Dispatcher Model TD1 by Philco-Canada

DOES NOT REQUIRE SKILLED OPERATOR!

- Sends fixed or variable messages over conventional teletype circuit.
- Messages can contain letters, symbols or figures as required.
- Handles up to 400 characters.
- Fixed information is permanently wired into circuit. Readily changed as required.
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- A 24-hour time clock prints the time the message is sent in teletype code.
- Several different messages can be composed at one time.
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- Messages can be easily checked for accuracy before transmission.
- Custom symbols can be added as required.

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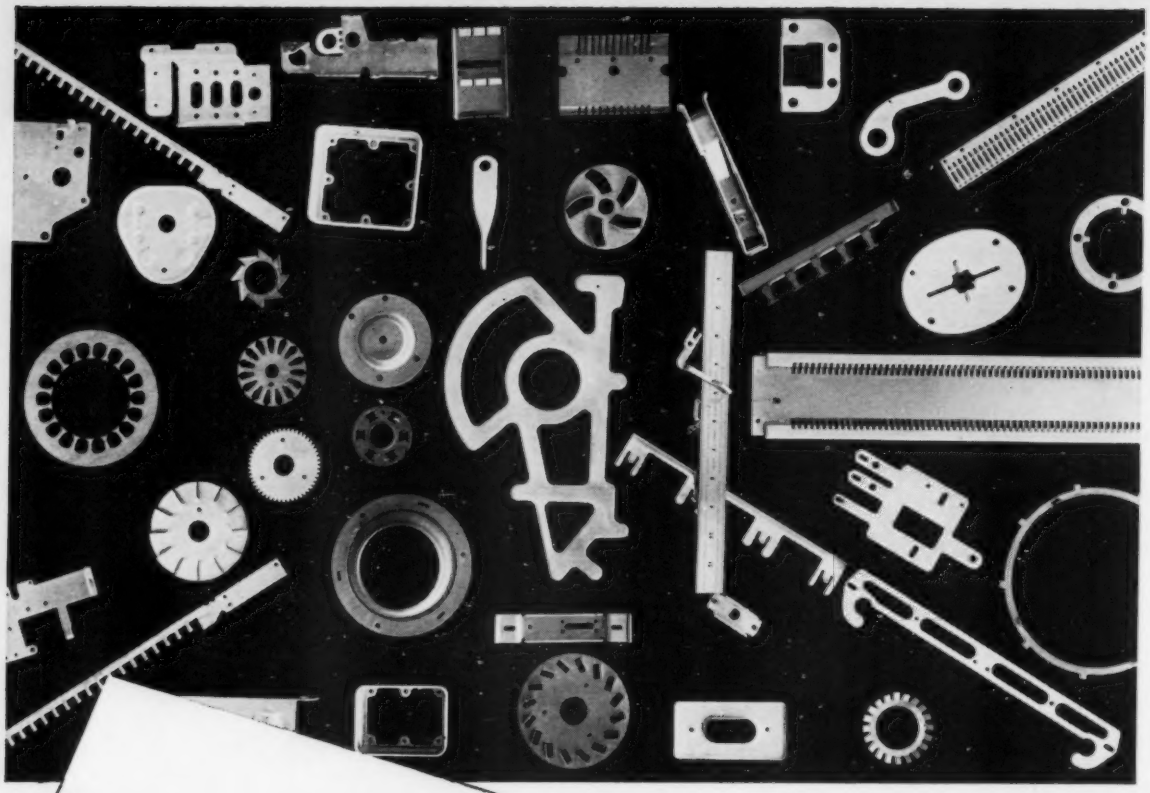

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A problem which often haunts the fast-thinking, fast-working design engineer is the inability of his own plant — either in terms of machine capacity, time or cost — to turn out a complicated stamping in relatively small quantities — fast. More often than not it's a question of modifying the stamping (and thereby making it second best) or waiting the long and costly wait while dies are made.

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ROGERS

REFERENCE BULLETIN NO. 6

Rogers transistors for audio applications

Rogers now offer a broad range of low thermal resistance transistors for low-level, small signal amplifiers and up to 30 watts audio output.

All Rogers *Low Power* types are hermetically sealed for maximum reliability.

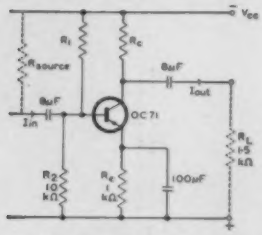
All Rogers *High Power* types are sealed in standard TO3 package.

All Rogers *Large Signal* types are designed for minimum change in current gain at large collector currents.

Types OC72 and OC74 are available in matched pairs for low spread in quiescent collector currents used in Class B push-pull circuits.

Low Power Input and Driver Stages

	V_{CE}	W_C	β	f.c.o.	
OC70	30	125mw	30	.45mc	low gain
OC71	30	125mw	50	.5mc	medium gain
OC75	30	125mw	90	.75mc	high gain

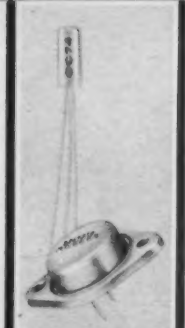


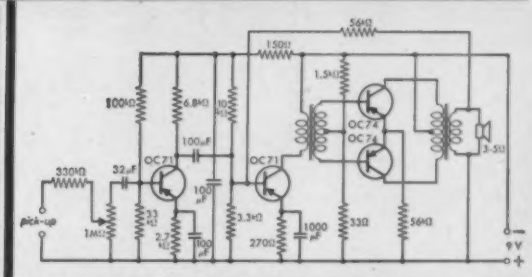
Typical OC71 preamplifier

Medium and High Power Output Stages

	V_{CE}	W_C	β	f.c.o.
OC72	32	165mW†	70	.9mc
2-OC72	Matched pair of OC72 for class B output stages.			
OC74	20	550mW†	65	1.5mc
2-OC74	Matched pair of OC74 for class B output stages.			
OC22	32	10W	150	2.5mc
2N1314	32	20W	33	.15mc
2N1315	32	20W	64	.3mc

†with mounting clip 56200 and heat sink 2in.



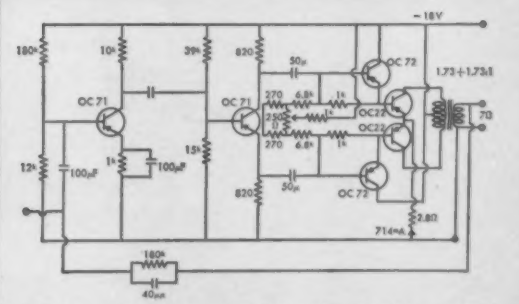


Circuit diagram of 1W(r.m.s.) phonograph amplifier. Frequency response 30cps to 14 kc/s. Sensitivity for full output 750mv. Sensitivity using OC75 in place of OC71 250mv. Total Harmonic distortion 5% at Full Output.

Survey of Output Transistor Performance

	Circuit	Supply Voltage	Power Output (r.m.s.)
OC72	Class A	6	38mw
		12	38mw
	Class A	9	75mw
	Sliding bias	12	100mw
	Class B, Push-Pull	6	310mw
		12	390mw
OC74	Class A	6	110mw
	Class A, Sliding bias	9	200mw
	Class B, Push-Pull	6	810mw
		9	1.26w
OC22	Class B, Push-Pull	12	4.0w*
2N1314	Class A	7	4.0w
	Class B, Push-Pull	7	10.0w
		14	20.0w

*OC22 for "hi-fi" amplifiers. See circuit.



Experimental circuit for 4 Watt "Hi-fi" Amplifier. Total harmonic distortion at 4W output <1%. Frequency response ±2db 20cps to 20 kc/s. Sensitivity (for full output) 30μA.

This reference sheet is one of a series from Rogers to keep you fully informed of electronic developments. A specially designed file folder for these bulletins is available from Rogers on request.

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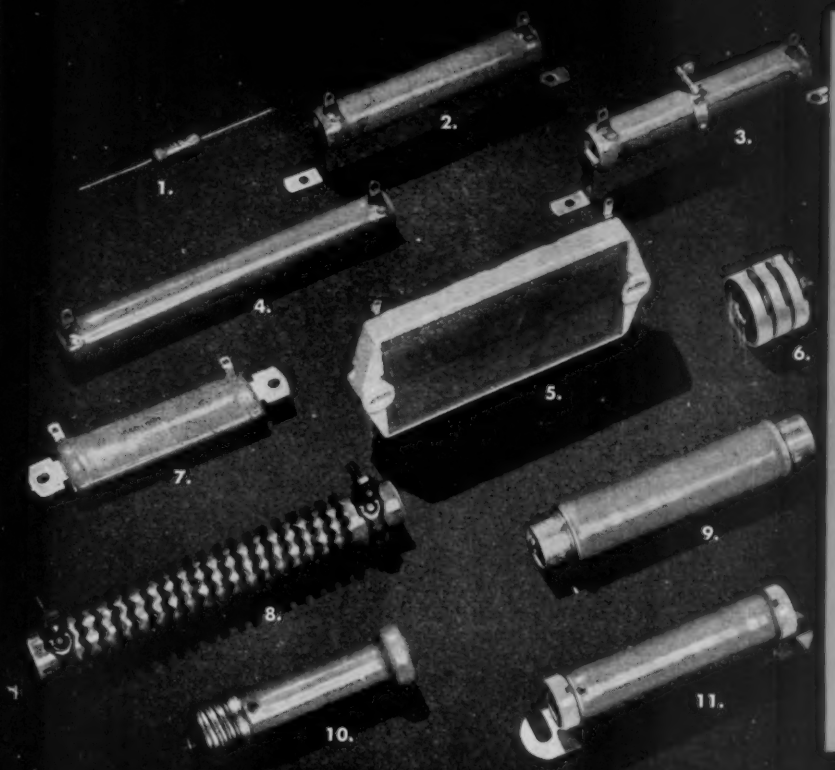

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. . . the world's largest selection

1. AXIOHM* Used in electronic equipment requiring miniature power resistors. **2. FIXED VITROHM*** Used for voltage dropping and current limiting. **3. ADJUSTOHM*** Gives circuit adjustability for voltage dividing or regulating purposes. **4. NON-INDUCTIVE*** For low inductance and distributed capacitance in high frequency circuits. **5. PLAQOHM*** Used in compact, high frequency electronic equipment. **6. DISCOHM*** A miniature resistor for low inductance values and distributed capacitance. **7. STRIPOHM*** For compact aviation, communication and navigation equipment. **8. RIBFLEX** Used in circuits where high wattage must be dissipated in small space. **9. FERRULE TERMINAL** For rapid interchangeability of resistance values or resistor replacement. **10. SCREW BASE** With an Edison screw base for mounting to provide rapid means of changing resistance. **11. BRACKET TERMINAL** Has leads silver brazed to brackets for easy interchange or renewal of unit.

**These are stock resistor types*

Ward Leonard Vitrohm resistors will best meet your every requirement

• The eleven resistor types shown above (seven of them stock resistors) represent the most complete line ever offered by any manufacturer.

We carefully control every step in the manufacture, and run more than 19 separate inspection checks on every single resistor we produce to make sure it will perform as rated, even under the most adverse conditions.

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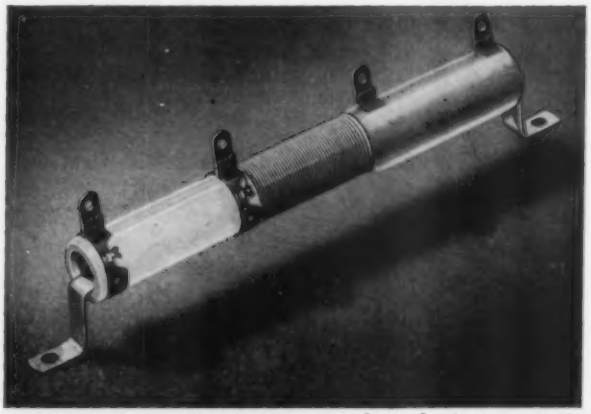

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Pye Portable Public Address equipment has printed circuits and is fully transistorized . . . to provide excellent performance, rugged dependability and long battery life.

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Entirely self-contained, the Transhailer operates from ordinary flashlight batteries. Weighs 5 lbs. Easily handled.

SLINGHAILER
Similar to the Transhailer except that microphone is separate and a sling is provided for over-the-shoulder carrying. Can also be stood or mounted at any angle. Weighs 5½ lbs.

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The Portable Transistor Amplifier weighs only 5½ lbs. and measures 8" x 3½" x 6". Delivers up to 10 watts output. Available for either 12V. or 24V. D.C. operation.

PTC 1003 — 'TRANSHAILER'

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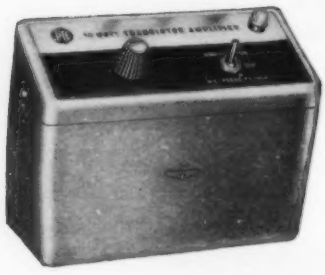

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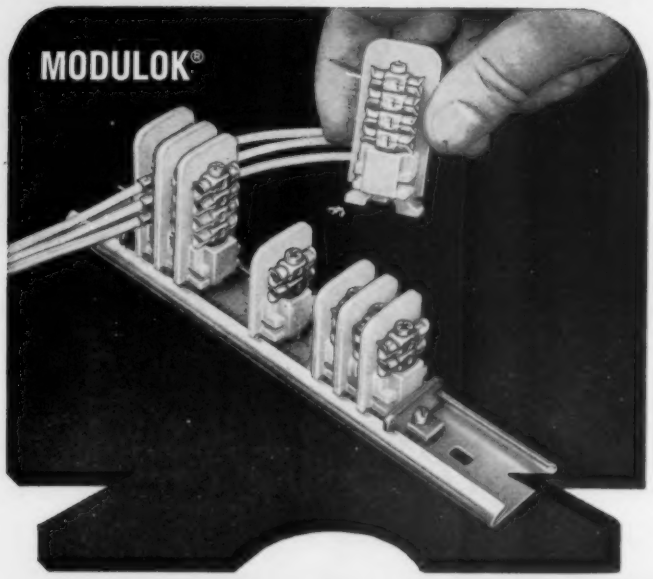

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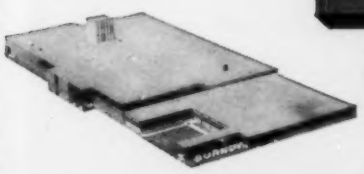

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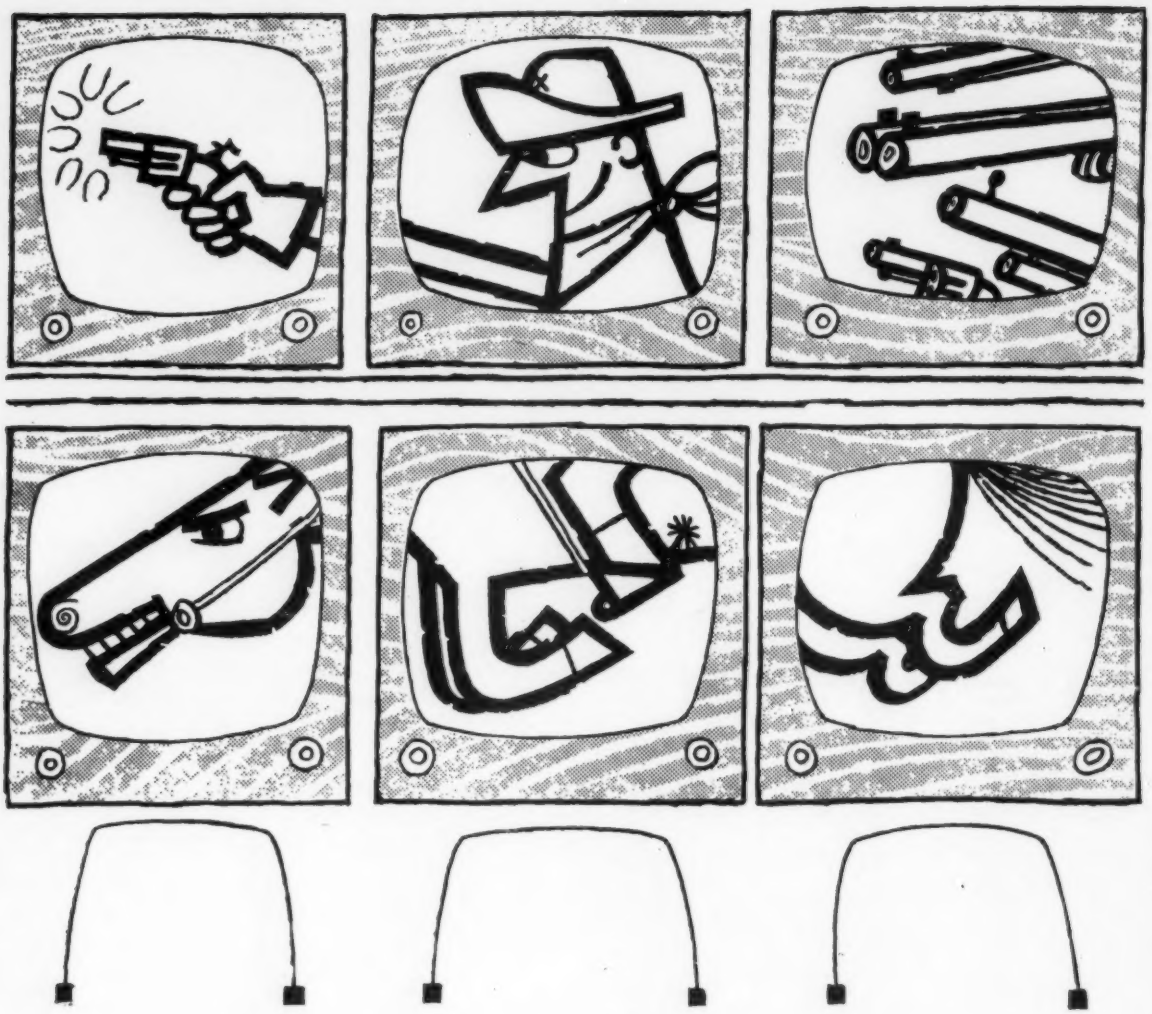

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Once again in 1959, more new television sets were equipped with Canadian Marconi TV Picture Tubes than any other brand. Again indeed! Since the beginning of TV set production in Canada, more Marconi TV picture tubes have been used than any other brand. ■ This consistant acceptance by Canada's leading TV set manufacturers is proof of the dependable quality and performance of Marconi Picture Tubes. ■ For complete customer satisfaction specify MARCONI RVC PICTURE TUBES.

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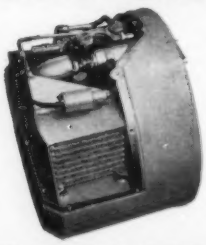

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Top-flight VAMISTOR performance starts back in the shop with Weston Quality Control – the most thorough, stringent system of testing now used to assure VAMISTOR reliability . . . *reliability in no uncertain terms!*

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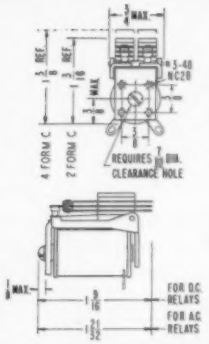
A multiple choice of terminations add to the MH's versatility. This relay, for example, can be adapted for printed circuits, furnished with taper tabs or a long list of other terminals. Get all the facts by calling your nearest P&B sales engineer today.



MH ENGINEERING DATA

GENERAL:

Breakdown Voltage: 500 volts RMS between all elements.

Ambient Temperatures: −45° C to +85° C. (−65° C to +125° C on special order.)

Shock: 30g on special order.

Vibration: 10g from 55 to 500 cps.; .065" max. excursions from 10 to 55 cps. on special order.

Weight: 2½ ozs. max. (open relay)

Terminals: Pierced solder lugs; special lugs for printed circuits, taper tab (AMP #78).

CONTACTS:

Arrangements: Up to 9 springs per stack.

Material: ⅛" silver standard. Palladium or gold alloy also available.

Load: Dry circuits to 5 amps @ 115V AC res.

COILS:

Resistance: 22,000 ohms max.

Power: 100 mw per movable min. to 4 watts at 25° C max. (200 mw min. to meet max. shock/vibration spec.)

Duty: DC: Continuous. AC: Intermittent (Two pole relay max.) open. Sealed units supplied with full wave rectifier inside can.

Voltages: DC: Up to 110 volts. AC: Up to 230 volts 60 cycles.

The relays below are variations of the MH relay structure.

MA LATCHING
Electrical latch, mechanical reset. Small, versatile and offered with selection of contact arrangements.

MB CONTACTOR
Contacts rated 60 amp. 28 volts DC non-inductive. Will carry 150 amp. surge for a duration of 0.3 seconds.

MH SEAL-TEMP
Features sealed coil to minimize contact contamination. Available as hermetically sealed relay only.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

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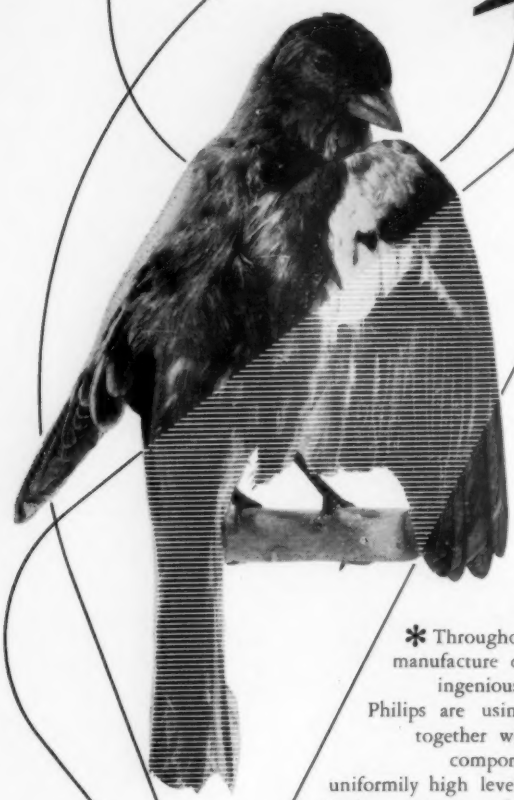

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Wide range available

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Frequency range 4.5 - 300 Mc/s
High frequency accuracy and stability
Carrier distortion 5%
Output voltage from 0.1 μV up to 1 V
Frequency sweep max. 250 kc/s
Modulation depth max. 30%
Built-in output, sweep and mod. depth meter
Built-in crystal oscillator
Tropic proof

Quality, reasonably priced

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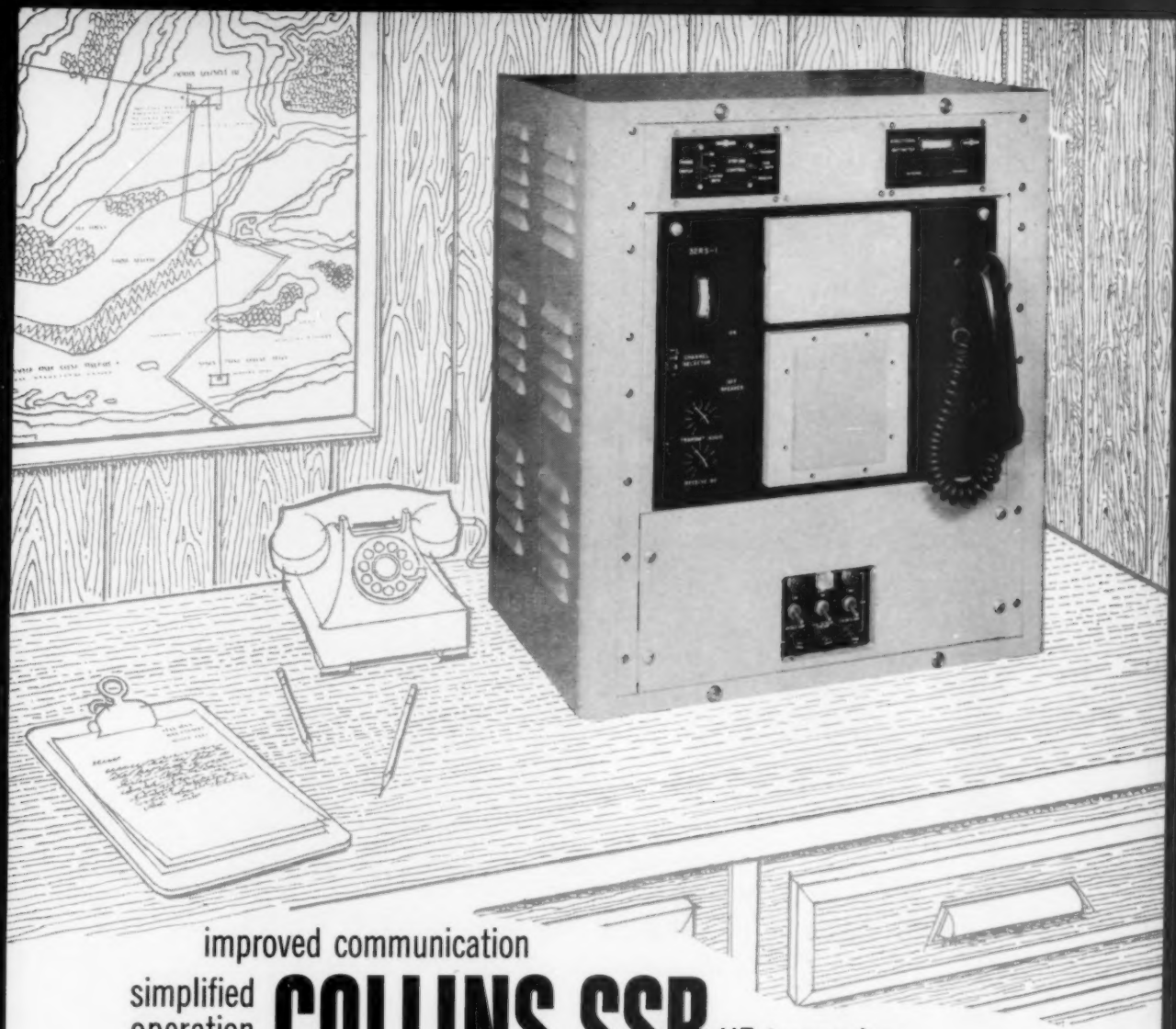

improved communication

simplified operation with COLLINS SSB HF transceiver

The compact Collins 32RS-1 offers: the full advantages of Single Sideband; more talking power, less bandwidth, and immunity to selective fading. True simplification for even non-technical operators has been achieved by design excellence, not compromise. Highly stable circuits assure "on frequency" operation without an additional manual adjustment control. Simplified, improved design gives long, reliable service.

The 32RS-1 can provide up to 4 crystal-controlled frequencies in the 1.6 to 15 mc range, selected by a flick of a selector switch. In transmission it provides 100 watts peak envelope power output—Single Sideband "talking power" 3 db higher under normal conditions, 9 db higher under severe fading, than that of AM equipment with equivalent rating. A balanced modulator and Mechanical Filter sideband generator, multiple tuned circuits and linear amplifier assure a clean signal in transmission, while automatic load control maintains a high level of "talking power" by compensating for changes in voice level. In reception the Mechanical Filter provides excellent selectivity for the desired signal and rejection of off-channel interference.

The 32RS-1 is also suitable for use in mixed AM/SSB systems, since compatible AM operation (reinserted carrier) is available at the flick of a switch.

A special feature of the 32SR-1 is VOX control, with the transmitter actuated by the voice of the person speaking over the circuit. This makes it possible to operate the transceiver through telephone extensions or switchboards without extra push-to-talk switches.

The 32RS-1 also simplifies the maintenance technician's task, with components and maintenance adjustment controls readily accessible, and test meter and transmitter alignment generator built-in.

Contact your nearest Collins distributor or write for literature on the 32RS-1 and complete station accessories — antennas, antenna couplers, directional wattmeters, phone patches and remote control equipment.

COLLINS

COLLINS RADIO COMPANY OF CANADA, LTD., TORONTO 16, ONTARIO

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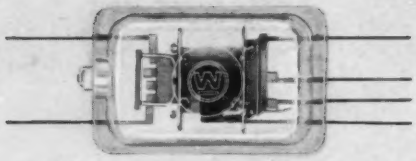
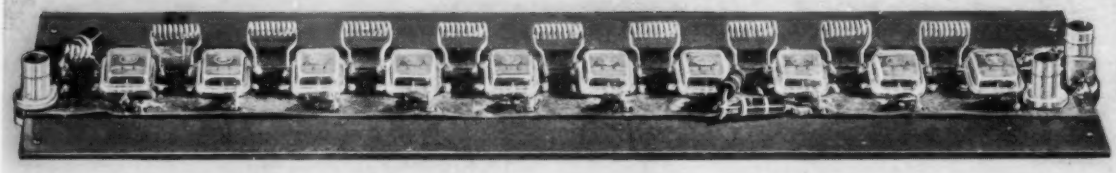
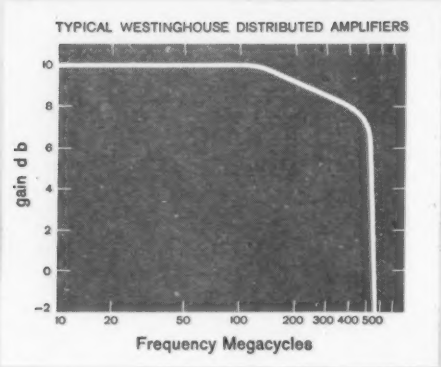
Westinghouse tube engineering... serving the nation through imagination





GAIN AT HIGHER FREQUENCIES



with Westinghouse distributed amplifiers

The new Westinghouse Match Box Tubes provide distributed amplifiers with response to 550 MC.

Match Box tubes surpass conventional tubes in high frequency performance and resistance to vibration. Tubes lie flat . . . no height problem . . . eliminates sockets, fits printed circuits.

Westinghouse Distributed Amplifiers can be designed with various frequency pass bands. They're especially suited for electronic counter-measure circuits and for high-speed, high-frequency oscilloscopes.

For complete information write to Canadian Westinghouse Company, Limited, Electronic Tube Division Box 510, Hamilton Ontario.

CHARACTERISTICS WX3683

Heater 6.3 Volts	0.2 amperes
Plate current	8 milliamperes
Transconductance	5100 micromhos
Plate Voltage	180 volts

YOU CAN BE SURE... IF IT'S Westinghouse

60C800

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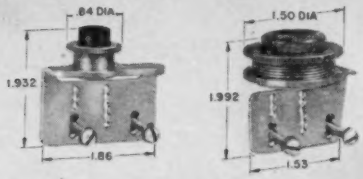


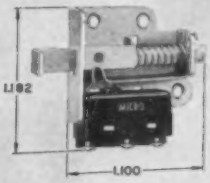
12MA1 Actuator 12MA5 Actuator

Pushbutton actuators are versatile, low cost

These actuators accept three families of basic pin plunger switches permitting their use in a wide range of applications. Two button sizes—½" and 1"—and choice of red, green or black buttons give panel distinctiveness. Switch and actuator mounting hole arrangement permits use in panels from .060" to .312" thick, and simplifies button travel adjustment. Data Sheet 155.

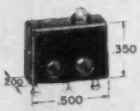
New subminiature "TM" toggle switch uses minimum panel space

The 2TM1-T offers considerable reductions in space and weight in manual control of compact equipment. Weight—4½ grams. Only ½" square at the base. Dependable operation from −65° to +200°F. Low circuit resistance. Rating: 7 amps. resistive, 28 vdc. DPDT. Data Sheet 158.



New subminiature safety door interlock

The 17AC1-T cuts off power in equipment cabinets when a service door is opened. Manually pulling the rod actuator to maintained contact position closes circuit for checking. When door is next closed, switch returns to normal . . . resets itself to safety position. Dependable in temperatures from −65° to +250° F. SPDT. Data Sheet 159.



ACTUAL SIZE

Sub-subminiature series switches

These remarkable switches combine smallest available size with "regular size" electrical capacity, operate dependably in temperatures from −65° to +250°F. Weight—1/28 oz. Qualifies as Military Standard Part Number MS24547-1. Rating: 5 amps., 230 vac; 7 amps. resistive, 28 vdc. Data Sheet 148.

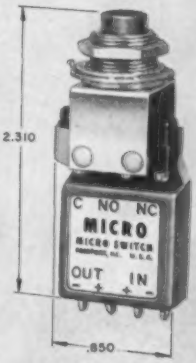
LEAF ACTUATOR

ROLLER LEAF ACTUATOR

Auxiliary actuators add to the versatility of application. Two are shown. Others are pivoted lever and pivoted roller lever. All are stainless steel.

"One-Shot" switches simplify circuit development

Time-consuming custom development of circuits is made unnecessary by "1PB600" Series "One-Shot" pushbutton switches. These switches produce one square wave pulse per operation. Pulse widths from 0.1 to 10.0 microseconds. Applications include computer and radar consoles, electronic test equipment, setting and resetting flip-flops, and reflected pulse systems. Data Sheet 150.



Selections from a line large enough to solve almost any switching problem

MICRO SWITCH makes many hundreds of switches and switch devices especially useful to the electronic designer. Here are a few of them, in a considerable range of sizes, electrical capacities, and functions. MICRO SWITCH development engineers are constantly widening the choice with new switches and devices to meet new requirements. The designer can go ahead with a switching arrangement he has in mind with confidence that MICRO SWITCH can supply his need.

Engineering assistance in switch applications is available without obligation from your nearest Honeywell office, or write Honeywell Controls Limited, *Precision Components Division*, Toronto 17, Ont.

H HONEYWELL **Honeywell**

MICRO SWITCH Precision Switches

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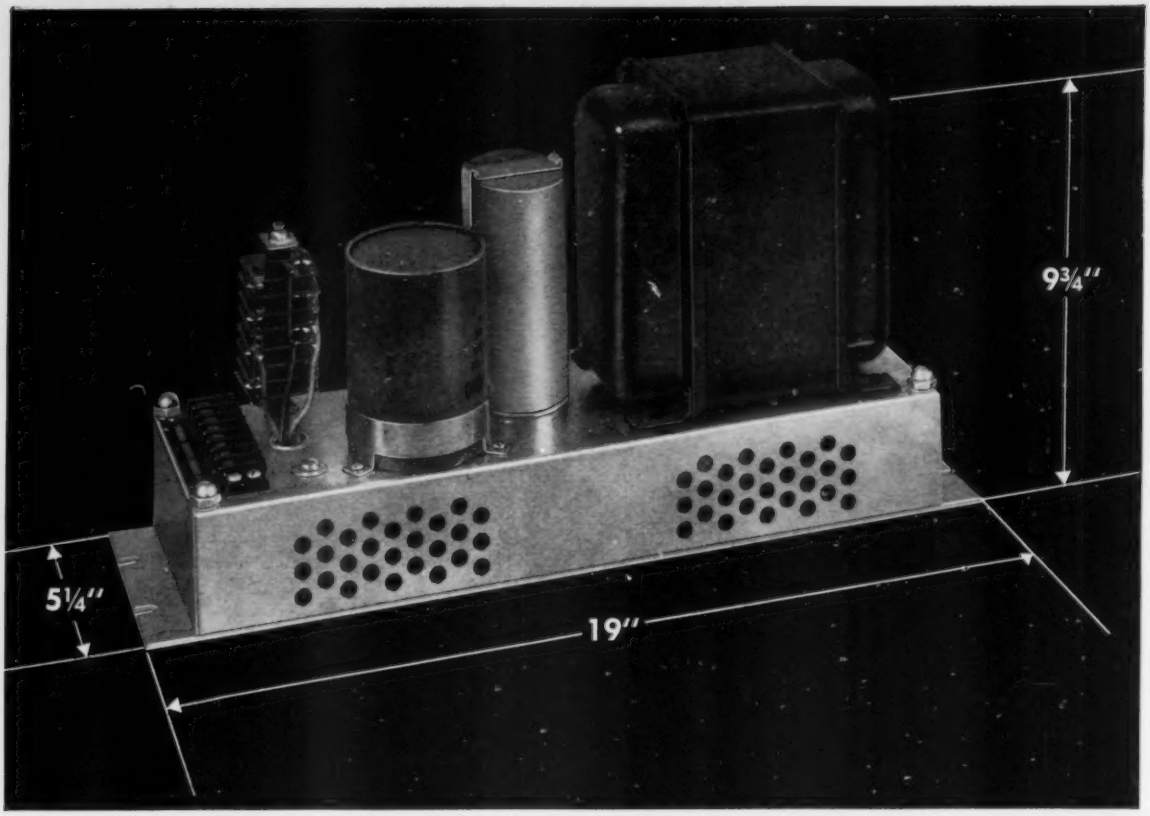


Sola Constant Voltage DC Power Supplies are designed for intermittent, variable, pulse or high-amperage loads.

Sola packs 6 amps of 300-watt regulated dc power into 5¼ inches of relay-rack space

Looking for a source of regulated dc power that fits into a small space? You'll probably find that the Sola Constant Voltage DC Power Supply offers what you want.

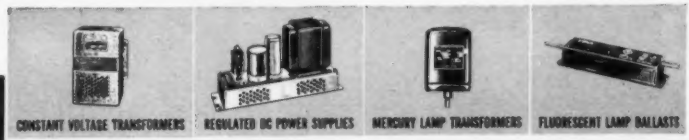
This compact unit has exceptional performance characteristics, too — it delivers current in the "ampere range," regulates within ±1% even under a ±10% variation in line voltage, has less than 1% rms ripple, and even tolerates dead shorts. It is 80% efficient and has a very low static output impedance.

How's it done? Sola managed it through a balanced assembly of three complementary components . . . a special Sola Constant Voltage Transformer is teamed up with a semiconductor rectifier and a high-capacitance filter. Electrical characteristics of the transformer maximize most of the advantages of the rectifier and filter, while virtually eliminating all their disadvantages. The resulting regulated dc power supply is simple, highly reliable, compact and moderately priced.

These benefits are exhibited by the entire line of Sola dc power supplies. Sola has designed and produced hundreds of ratings to meet requirements of equipment manufacturers. The company is set up to handle specific needs for custom-designed units in production quantities. A Sola sales engineer can supply all the facts. In addition to this custom service, Sola currently stocks six models ranging from 24 volts at six amps to 250 volts at one amp.

For complete data write for Bulletin 52C-CV-235

SOLA



SOLA ELECTRIC (CANADA) LTD. B P C

A Subsidiary of Basic Products Corporation

377 Evans Ave., Toronto 18, Ont., Clifford 1-1147 · In U.S.A., Sola Electric Co., 4633 W. 16th St. Chicago 50, Ill.

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2 NEW

GENERAL-PURPOSE OSCILLOSCOPES

introduce TEKTRONIX QUALITY to the DC-to-450 KC RANGE

The Tektronix Type 503 and Type 504 are the first of a family of new oscilloscopes for the DC-to-450 KC application area.

- **Both feature high reliability, simple operation, light weight.**
- **Each excels in performance characteristics in its class.**
- **Both now established as production instruments.**

Prices to be announced at the IRE Show Booths 3027 to 3030

TYPE 503

The Type 503 is a differential-input X-Y oscilloscope with the additional features—linear sweeps, dependable triggering, sweep magnifier, bright trace, amplitude calibrator—desirable for general-purpose applications.

FREQUENCY RESPONSE
dc to 450 kc

VERTICAL AND HORIZONTAL AMPLIFIERS
Differential input at all attenuator settings.
1 mv/cm to 20 v/cm in 14 calibrated steps.
Continuously variable between steps, and to approximately 50 v/cm uncalibrated.
Constant input impedance at all sensitivities (standard 10X probes can be used).

SWEEP RANGE
1 μsec/cm to 5 sec/cm in 21 calibrated steps.
Sweep time adjustable between steps, and to approximately 12 sec/cm uncalibrated.

SWEEP MAGNIFICATION
X2, X5, X10, X20, and X50 Magnification.

AMPLITUDE CALIBRATOR
500 mv and 5 mv peak-to-peak square-wave voltages are available from front panel.

3-KV ACCELERATING POTENTIAL
5-inch Tektronix crt provides bright trace, 8-cm by 10-cm viewing area.

EASY TRIGGERING
Fully automatic, amplitude-level selection on rising or falling slope of signal, or free-run (recurrent). AC or DC coupling, internal, external, or line.

REGULATED POWER SUPPLIES
All critical dc voltages electronically-regulated, plus regulated heater supplies for the input stages of both amplifiers.

SIZE AND WEIGHT
13½" h, 9¾" w, 21½" d—approximately 29 lbs.

TYPE 504

The Type 504 has the basic features desirable for most general-purpose applications — sensitive vertical amplifier, linear sweeps, easy triggering, amplitude calibrator.

FREQUENCY RESPONSE
dc to 450 kc

VERTICAL AMPLIFIER
5 mv/cm to 20 v/cm in 12 calibrated steps.
Continuously variable between steps, and to approximately 50 v/cm uncalibrated.
Constant input impedance at all sensitivities (standard 10X probe can be used).

SWEEP RANGE
1 μsec/cm to 0.5 sec/cm in 18 calibrated steps.
Sweep time adjustable between steps, and to approximately 1.2 sec/cm uncalibrated.

AMPLITUDE CALIBRATOR
500 mv and 25 mv peak-to-peak square-wave voltages are available from front panel.

HORIZONTAL INPUT
0.5 v/cm, with variable attenuator.

3-KV ACCELERATING POTENTIAL
5-inch Tektronix crt provides bright trace, 8-cm by 10-cm viewing area.

EASY TRIGGERING
Fully automatic, amplitude-level selection on rising or falling slope of signal, or free-run (recurrent). AC or DC coupling, internal, external, or line.

REGULATED POWER SUPPLIES
All critical dc voltages electronically-regulated, plus regulated heater supplies for the input stages of the vertical amplifier.

SIZE AND WEIGHT
13½" h, 9¾" w, 21½" d—approximately 29 lbs.

Rack-mounting models will be available, of course!

Tektronix, Inc.

3 Finch Avenue East, Willowdale, Ontario
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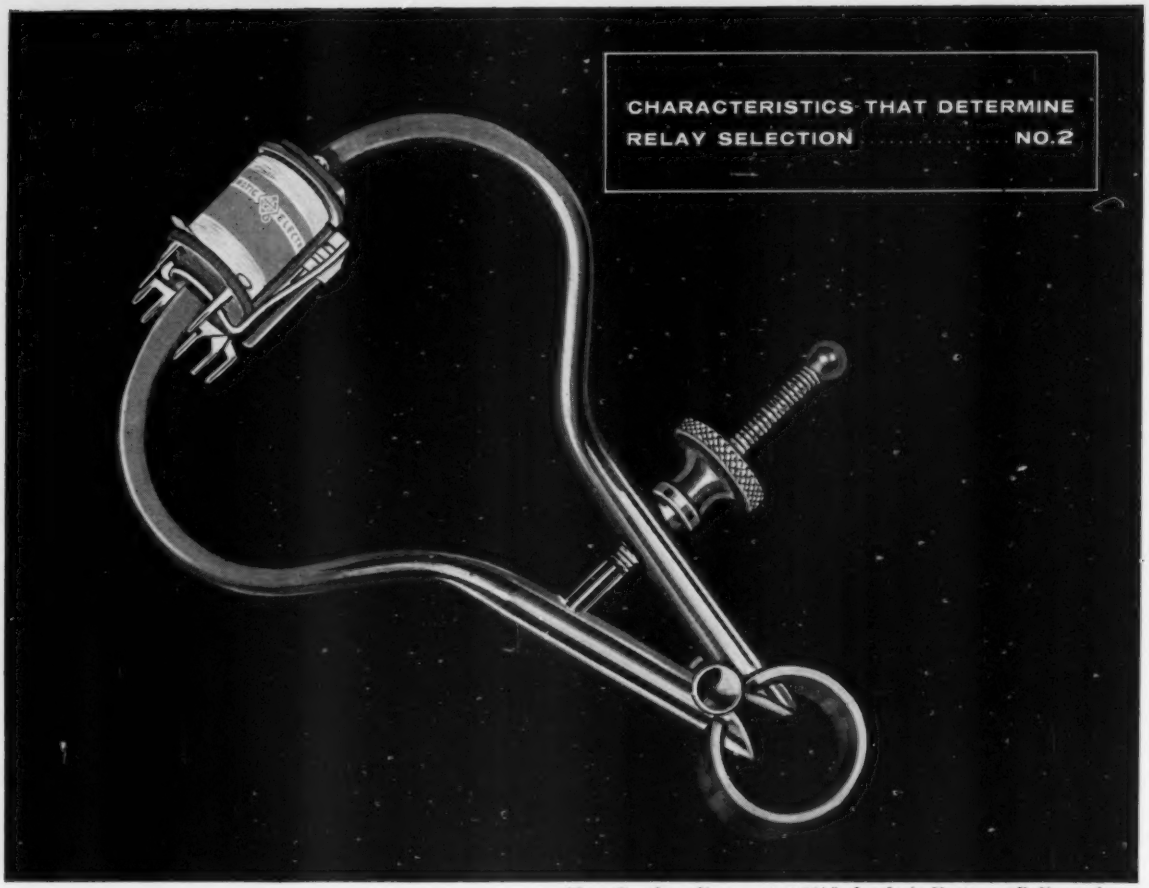

Class S—the calipers set at 1¼" clearly indicate small dimensions.

where a small, light relay is required

Helpful selection data Class S Series

OPERATING VOLTAGE:
Up to 115 volts *d.c. only*

CONTACTS:
Normally twin, Code 0-20 ga. Will carry up to 135 watts (max. 2 amps) inductive or non-inductive load. Special contacts as required.

CONTACT CAPACITY:
1 pile-up, maximum 7 springs

COILS:
Up to 7,000 ohms

OPERATING TIME:
Range, 0.002 to 0.030 second

RELEASE TIME:
Range, 0.005 to 0.085 second

RESIDUAL:
Fixed (armature or chromium plated)

The Class S relay by Automatic Electric, is extremely small and weighs less than two ounces, yet it will carry a contact load of 135 watts—or more. Designed to operate in aircraft and on other small-space, high-reliability applications, the Class S has been thoroughly proven under extreme operating conditions, and will pass armed services shock and vibration requirements to 10G. Because of its small mass and slight self-inductance, it can be relied on for fast pulse response.

This is a precision-built, quality relay unaffected by temperature extremes or by high humidity. Uniquely shaped contact springs provide maximum contact dependability . . . either of the twin contacts can complete the circuit alone . . . and their self-cleaning action assures positive contact and low resistance—every time.

The Class S is one of the finest relays of its type on the market. Call or write Automatic Electric Sales (Canada) Limited, 185 Bartley Drive, Toronto 16, Ontario. Branches in Montreal, Ottawa, Brockville, Hamilton, Winnipeg, Regina, Edmonton, Vancouver.

AUTOMATIC ELECTRIC

GENERAL SYSTEM

Subsidiary of
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AN ORGANIZATION SERVING CANADIAN INDUSTRIES WITH COMMUNICATION, TIME AND CONTROL SYSTEMS

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CANADIAN
ELECTRONICS
ENGINEERING

Radical technique 'grows' complete circuits from semiconductors

Utilizing new production techniques, scientists at Westinghouse Corporation can create, modify and process materials with the ability to perform electronic tasks through solid-state phenomena

Efforts to elevate air and space craft to new plateaus of capability are continually made more difficult through a technical paradox. As we make these craft more sophisticated through the use of advanced electronic gear, the risk of failure among components and connections grows. And as we add this more complex electronic equipment it becomes more difficult to provide for its weight and size.

As a result, focused programs for the improvement of reliability plus weight and size reduction of electronic equipment are now under way in several locations. These problems may be approached in several ways. For example, improved reliability can be realized by better quality control on components and connections. However, the probability of simultaneous successful operation of all components in any system is the product of all the individual probabilities of a component functioning without failure, and better quality control does not invalidate this limitation imposed by the laws of probability. Smaller and lighter components in more compact packages can be obtained by miniaturization, but such techniques, while exploiting modern technology, do not yield maximum reliability.

In the recent past, a substantial part of Westinghouse research and development effort has been focused on a new and quite distinct approach to both problems. It exploits a new concept in the design and function of electronic systems which we call "molecular electronics" to indicate its dependence on phenomena occurring within or between domains of molecules in the solid state.

Recognizing the potential importance of this concept to defense, the Wright Air Development Division's Air Force Electronic Technology Laboratory has directed the employment of Westinghouse facilities in a program to prove its feasibility. Specific objectives were: to determine to what extent molecular electronics can be used to perform complex functions in several systems of basic importance to the Air Force; to develop subsystems for use in those systems; and to develop new materials that will advance the usefulness of the concept.

As one accomplishment of the joint program, we are now producing a variety of molecular electronic "function blocks," three of which are shown in Fig. 1, as solid-state elements that achieve, entirely within themselves, electronic results such as have been gained only by assembling many, varied items of electronic hardware. Because of this, these elements are not intended as "components," as we think of transistors and tubes, but rather as "subsystems" since each of the function blocks has the ability to achieve an electronic result which is essential if all the subsystems in the entire system are to work together effectively. Examples of functions performed by function-blocks are such electronic operations as amplification, oscillation, and telemetering.

Because there are no internal connections or components, and the only external connections needed are those for coupling inputs and outputs to the complete system, we are able to build subsystems whose risk of failure should be equal to or less than that of familiar solid-state devices and perhaps one-thousandth of that for a subsystem built of many parts for the same purpose. This ability of

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This is a condensation of a technical paper presented by Dr. S. W. Herwald, vice-president, research, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania.

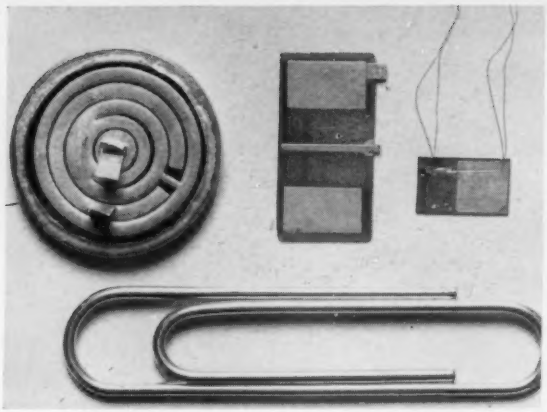


Fig. 1. Three molecular electronic function blocks demonstrated as subsystems. Left to right: audio amplifier, free-running multivibrator, two-stage video amplifier.

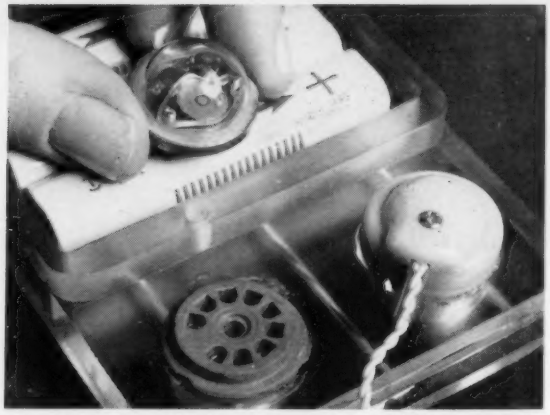


Fig. 2. Light telemetry subsystem in which single light-responsive monolithic element delivers an output signal whose frequency is a measure of the light intensity.

molecular electronics to reduce the number of components and connections required is illustrated by a comparison of three designs for a light telemetering subsystem, Fig. 2. When designed to use electronic tubes, this subsystem required 16 components and 18 soldered connections; when designed to use transistors, it required 14 components and 15 connections. In contrast, a molecular electronic subsystem was developed to achieve the same purpose, needing but one component and two connections.

Also, because their internal functions involve distances of the order of a few atomic spacings, these function blocks are almost microscopically small and virtually weightless.

Function blocks prove feasibility of molectronics

Eight classes of function blocks have been developed to demonstrate the feasibility of molecular electronics at frequencies ranging from infrared to direct current.

These function blocks are: (1) a 5-watt directly cascaded audio amplifier, (2) a two-stage video amplifier, (3) a frequency selective amplifier with notch filter in a feedback loop around the amplifier structure, (4) a variety of multivibrators — bistable, monostable and astable, (5) a variable potentiometer based on logarithmic addition of two inputs, (6) a variety of multiposition switches (including an "OR" switch, a multiple npnp Dynistor switch, and a multiple npnp Trinistor switch with firing electrode), (7) an analog-to-digital converter employing an npnp relaxation oscillator, and (8) a two-stage cooler, employing the Peltier effect, covering frequencies from 1 cycle or less to 3 megacycles, for cooling infrared detectors to proper operating temperatures.

As the basis for these molecular electronic subsystems, we have a very substantial knowledge of solid state phenomena developed over the past 30 years. It is simple now to create materials having excessive positive or negative electrical charges and, by placing these materials in physical contact with related materials, to bring about such phenomena as rectification or amplification, as in diodes and transistors. Also, we can readily take advantage of the ability of radiation to cause charge paths to occur in a semiconductor material along which current will flow when the material is irradiated.

Effects of this general type are used in molecular electronic blocks by creating, usually in single crystals, a number of distinct operative domains, which can be regarded as molecular "communities" having a common civic purpose, in that each domain will sustain a desired electronic occurrence. The domains border one another at boundaries called interfaces, which are like political frontiers in their ability to initiate phenomena different from those occurring inside the molecular domains.

The simple example in the element shown in Fig. 3 is composed of two domains which meet physically at one interface. One of these domains is composed of a resistive material selected and shaped to present a resistance R_1 to the passage of current; the other domain is also resistive, but is so planned that it has a resistance R_2. At the interface, the interaction between domains causes a capacitive effect. Thus, in one tiny element there is a subsystem equivalent to a time-delay circuit.

Another illustration of the uses of domains and interfaces is a function block designed as an ac-to-dc power supply for transistor circuits. It makes use of the Seebeck effect for the thermoelectric generation of electricity to convert 110-volt ac to 9-volt dc. In contrast, the conventional circuit, Fig. 4, requires five individual components. The molecular electronic building block consists of three separate domains.

When ac is applied to the resistance domain, the heat that is generated passes through the domain at the centre (this domain is an electrical, but not a thermal insulator) and into the thermoelectric domain where the energy is converted into electrical energy by the Seebeck effect. By proper control over the materials used, 9-volt dc output can be obtained.

An interesting aspect of the power supply is that elimination of ripple as an undesirable variation in voltage is inherent since heat flows from the resistive domain to the thermoelectric domain at practically a constant rate.

As these two examples suggest, the concept of molecular electronics makes no use of the traditional circuit-and-component approach to electronics. Instead, the objective is to use knowledge of the structure of matter to synthesize monolithic function blocks whose arrangement and composition permit each to serve as a substation to perform an electronic function in the control or transformation of energy.

To achieve function blocks with this capability, a number of effects and phenomena of the solid state are available. The only firm limitations on choice are that the effect must not react adversely on system reliability and must lend itself to consistent results when included in a function block. Methods typical of practice so far include: solid-state phenomena, such as Seebeck generation, Peltier cooling, and Hall-effect multiplication; the use of PN semi-

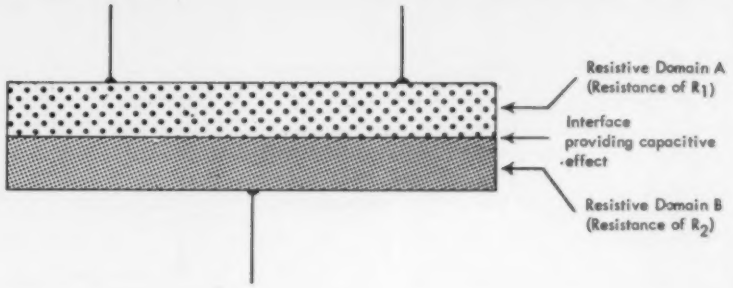


Fig. 3. Function block of two resistive domains and one capacitive interface, whose total effect is that of an RC or time-delay circuit.

conductor junctions arranged to produce a result which would otherwise require numerous individual components; and when necessary, fabrication of circuit elements within a function block. Although such phenomena will be most often used for the control of electrical signals, they will also be suitable when quantities like electromagnetic radiation, heat, and mechanical displacement are inputs or outputs.

System requirements dictate design

The design of a subsystem begins with the designer's analysis of the requirements of the system, to establish the functions to be performed by the function block. After logic processes are determined and suitable physical effects settled upon, a topologist — a mathematician who works with shapes — determines the structure of the block by designing, on paper, the arrangement of domains and interfaces that is to control the flow of energy in the block. The block is then produced by the materials engineers who use germanium and silicon as the basic semiconductor materials.

In producing these blocks we do not assemble them from various tiny components. Rather, we start with a basic semiconductor wafer and produce the necessary domains and interfaces by techniques used in the production of conventional semiconductor devices, including diffusion, plating, electron beam machining, etching, cutting, radiation, alloying, and photographic processes. Although the function block so produced can now perform its function, additional processing steps are required to encapsulate the block, protect it against shock and vibration, and make it stable under the conditions of temperature and radiation it will encounter.

The dominant theme, the essential philosophy of molecular electronics is that we can now create, modify, and process materials to endow them with the ability to accomplish electronic tasks through solid-state phenomena. The foundation of success has been our ability to develop new materials and to process available materials in new ways.

Dendrite process grows crystals for molectronics

One important illustration of the contributions made by materials scientists is the development of a method for the rapid production of semiconductor crystals in a form that requires no removal of material to make them into suitable wafers for use as transistors or as the basic elements of molecular electronic elements. This is the dendrite process announced several months ago, in which germanium crystals in the form of ribbons about one-eighth of an inch wide and a few thousandths of an inch thick, are produced by drawing them from a molten mass.

A serious disadvantage to conventional methods for the production of molecular electronic blocks is the wide variation in characteristics frequently displayed by wafers. In the production of transistors, this difficulty can be circumvented by testing a production run to select those with proper values. In molecular electronics, however, it is essential to have materials whose characteristics are uniform if the yield is to be acceptable.

The dendritic method is essentially a continuous process in which the germanium ribbon grows at a rate of 6 to 12 inches per minute and in the precise direction of crystal growth required for application. An additional advantage is that if a contaminant enters the melt during the process, the resulting inclusion is "self-healing" so that when the process is completed, the affected portion can be cut away and the unaffected portion used.

Now, although this dendritic method has immediate usefulness in molecular electronics today, we are confident that its greatest significance is its ability to bring about a number of completely new processes for producing functional blocks. We are now most interested in a recent modification which makes it possible and practical to carry out diffusion, plating, and evaporation processes directly or the crystal as it grows from the furnace melt. With this technique, we are able to create semiconductor devices ready for the attachment of leads. One of the first uses has been to grow transistors in the form of a long crystal.

(Continued on page 39)

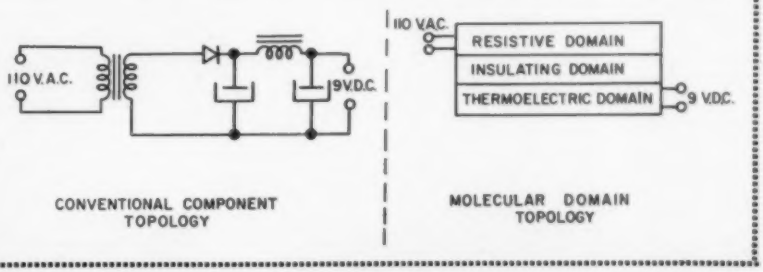


Fig. 4. Schematics of ac-to-dc power supplies show conventional method on left, and molecular element on right with resistive, electrical - insulating and thermoelectric domains.

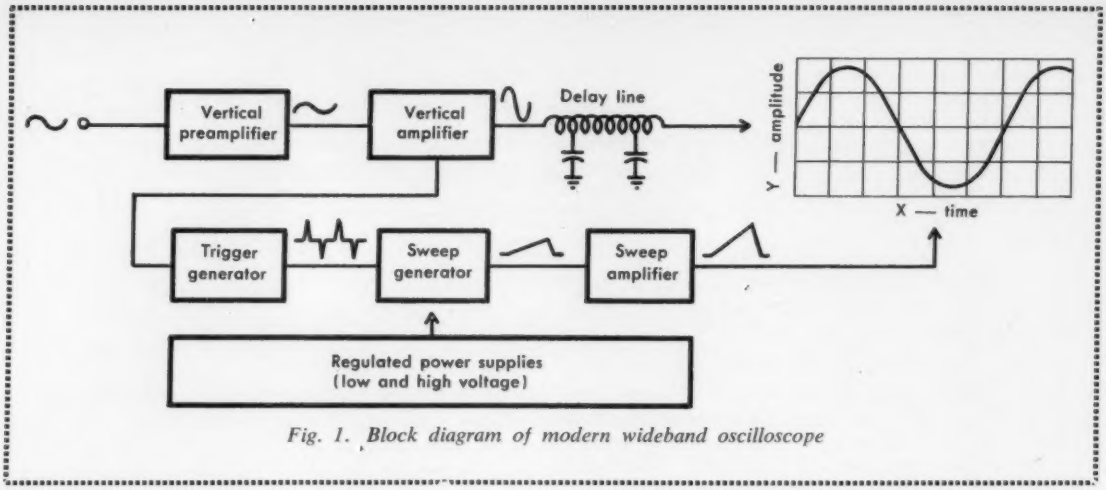


Fig. 1. Block diagram of modern wideband oscilloscope

New techniques extend bandwidth of cathode ray oscilloscopes

M. B. CROUCH, MEM.I.R.E., P.ENG.*

The author describes the various features of the modern wideband cathode ray oscilloscope, covering particularly those developments that have extended the bandwidth, such as pulse sampling techniques and distributed-deflection-plate tubes. Application notes are included to assist in choosing the most suitable instrument for each problem

Just over a decade ago the cathode ray oscilloscope was a low-bandwidth, synchronized indicating device. With the advent of radar, video amplifier and triggering techniques became known and were used in the earliest wideband oscilloscopes. Subsequent refinements have contributed to the general ease of operation; increased both amplifier bandwidth and calibration accuracy; and simplified application by making the instrument more versatile.

Future developments will extend the bandwidth even further with the use of distributed-deflection-plate cathode ray tubes and pulse sampling techniques; simplify triggering with the use of regenerative devices such as the avalanche semiconductors; and make possible the application of the oscilloscope to new fields. Fields such as chemistry, medicine, and mechanical engineering now require more detailed information at precise times, and their needs will be met by special accessories.

Fig. 1 shows the block diagram of a typical modern wideband oscilloscope. The various sections of the instrument are described in the following paragraphs.

Preamplifiers

The trend is to package the preamplifier section as a separate plug-in unit. This allows the user to vary the characteristics of the oscilloscope without investing in a whole new instrument for each new application requirement. Most of the plug-ins are designed to give a different gain with a corresponding change in bandwidth, the gain-bandwidth product being approximately constant. Some units, however, have functional features such as electronic switches, or are designed for a specific purpose such as transistor recovery-time or strain-gauge bridge measurements. It can be expected that many more preamplifier units will be developed for specific functions.

Pulse sampling

One such unit permits measurement and visual analysis of low-level, repetitive pulses with rise-times of the order of 0.6×10^{-9} sec; this is equivalent to increasing the resolution of the oscilloscope to 600 mc.

The principle of operation is similar to that involved in using a stroboscopic light to view a reciprocating engine. When the light is synchronized with the machine, the action appears to be stopped at the point in its cycle when the light is on. If, however, there is a repetition rate difference between light and machine, the machine appears to move at the difference rate: the observer sees samples of the machine's position, each sample close to the previous one and progressing in linear or angular position.

Similarly, the pulse-sampling unit translates high-speed pulses or wave trains down in bandwidth by displaying successive samples of amplitude as a series of dots on the crt face, which together form a composite picture of the original waveform. The fast strobe pulses for sampling are obtained by firing an avalanche transistor.

Vertical calibration

Vertical calibration of the oscilloscope began with a substitution method. A waveform of known amplitude was applied to the oscilloscope and its deflection compared with that of the unknown waveform. Depending on the momentary stability of the gain, the unknown could be compared to the known to an accuracy of 1% or better.

*Tektronix, Inc., Willowdale, Ont.

The absolute amplitude also depended on the accuracy of measurement of the known waveform. Other systems included one in which the waveform was moved over a reference mark and difference readings were taken from a calibrated positioning control. These ideas, however, were somewhat superseded by the convenience of a directly calibrated sensitivity control.

Regulated power supplies, stable amplifiers, and precision attenuators have made it possible to calibrate the input sensitivities directly, so that an operator can use the graticule markings to obtain accuracies of 2%.

A new plug-in unit using the slide-back technique has also been developed. This unit, however, differs from the earlier system in that one can slide back many screen diameters so as to make very accurate amplitude measurements; it is possible to read 1-volt or greater signals within 0.5%.

Another recent development involves the positioning of two display dots relative to the waveform on the face of the crt. The value of the voltage corresponding to the vertical distance between the dots is displayed digitally on the front panel of the oscilloscope to an accuracy of 2%. Connections are also provided for feeding the digital information or a proportional analog voltage to other equipment. The same system is applied to the X-axis of this instrument for direct readout of sweep time. It is claimed that up to 40% of oscilloscope use—time can be saved, and that use of the oscilloscope by unskilled workers in production control processes will be facilitated.

Yet another new instrument includes illuminated digital readout of vertical sensitivity and sweep time settings immediately below a rectangular crt. The readout location is within the picture area of existing oscilloscope cameras, causing sensitivity in volts per cm and sweep speed in time units per cm to become a permanent part of all waveform photographs.

Vertical amplifiers

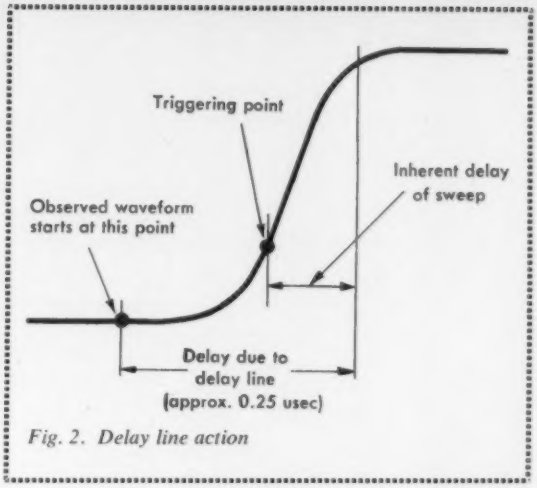
The direct-coupled amplifier is a must for pulse-video phenomena. Otherwise, to obtain accurate amplitude measurements of wave trains with changing video content, one would have to resort to clamping circuits to prevent the information from seeking new dc averages. Clamping circuits are frequency-selective and more troublesome than direct-coupled amplifiers.

The major factor that determines the upper bandwidth limit of today's oscilloscope amplifiers is the sensitivity of the vertical deflection plates of the crt. Wider band oscilloscopes normally use higher accelerating potentials. As the accelerating voltage is increased the beam becomes "stiffer" and the vertical plate sensitivity is decreased. To maintain a reasonable input sensitivity the amplifier must have more gain, but this can only be obtained with a sacrifice of bandwidth.

Cathode ray tubes in wider band oscilloscopes, therefore, are usually post-acceleration deflection types, in which the beam is first deflected, then accelerated. This allows for moderate deflection plate sensitivities but also provides high enough acceleration potential to register the high-speed information on the screen of the crt.

Bandwidth

Conventional amplifiers comprising plate-loaded, cascaded single stages give bandwidths up to 15 mc; distributed amplifiers are employed beyond this limit to give bandwidths ranging from 30 mc up to 100 mc. The bandwidth of the vertical system must, however, be considered from an over-all standpoint. When extra gain is required and an appropriate preamplifier is selected to achieve it, the bandwidth of the system must suffer. Maximum input sensitivities of 50 mv per cm of output deflection can be obtained over the bandwidths of 15 and 30 mc quoted above, and 100 mv-cm for the 100-mc oscilloscope. Greater input sensitivity requirements restrict the bandwidth of the system.


Triggering point
Inherent delay of sweep
Observed waveform starts at this point
Delay due to delay line
(approx. 0.25 usec)
Fig. 2. Delay line action

Main amplifier bandwidths will probably be extended in future oscilloscopes, but the gain-bandwidth figure with present day tubes has reached a limit. Only slight improvements are possible with higher figure-of-merit tubes since layout capacitances and inductances are the major problem.

The extension of bandwidth has already taken another course in the form of cathode ray tube design. Distributed-deflection-plate cathode ray tubes, sometimes called travelling-wave deflection-plate tubes, are now on the market. Although they do not have the sensitivity of lesser-bandwidth amplifier-crt combinations, they most certainly extend the bandwidth.

Working directly into a conventional crt, one can observe phenomena up to the resonant frequency of the plate system (the capacitance of the plates and the lead-in inductance); this varies from 250 to 500 mc, depending on the tube design. Sensitivities are of the order of 5 to 10 v/cm at 10 kv accelerating potential, again depending on the tube.

Distributed-deflection-plate systems are similar to a delay line and have a characteristic resistive impedance, a typical value being 125 ohms. The inductance and capacitance of these systems yield cut-off frequencies of 3 to 4 kmc, with a 3-db point of 1 kmc, and sensitivities of about 10 v/cm. The distributed-deflection-plate tube can be used with associated amplifiers; for example, the 100-mc oscilloscope mentioned above uses such a tube with a 900-ohm impedance. The amplifier, however, prevents full utilization of the bandwidth of the deflection-plate system. The 125-ohm tubes are designed for direct input and are essentially flat to 1 kmc, the 3-db point.

Delay lines

Most wideband oscilloscopes employ a delay line to allow observation of infrequent high-speed step functions in their entirety. The action of starting the sweep from a triggering point on the step function takes a definite period of time (fig. 2), so a delay line is included in the circuit to delay the vertical information a short while longer than this inherent delay of the start of the sweep.

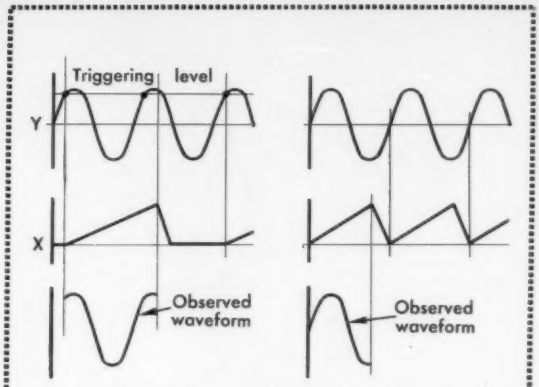


Fig. 3. Triggered and synchronized waveforms

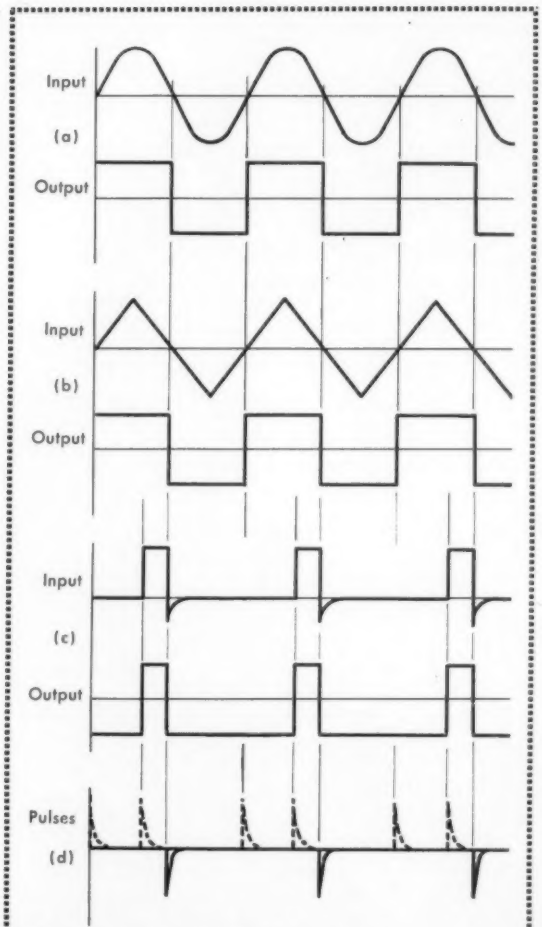


Fig. 4. Schmitt multivibrator waveforms

Triggering circuits

As shown in fig. 3, a triggered waveform differs from a synchronized waveform because triggering is dependent on a predetermined signal level, whereas synchronization depends on the time cycle of the waveform. In observing pulse signals, triggering is desirable: it would be difficult to see any detail in a very short time-duration pulse if one had to observe an entire pulse cycle. Modern oscilloscopes use the Schmitt multivibrator as a trigger generator because it functions well over a wide range of input signals to give a uniform output. As shown in fig. 4, the Schmitt circuit produces a square-wave output from a sinusoidal input (a), sawtooth input (b), or a pulsed input (c). In each case, differentiation of the square-wave output produces a train of negative-going pulses of equal time spacing (d) that are used for triggering.

The switching speed of a Schmitt squaring circuit is limited, even with constant current cathode provisions. Higher-speed oscilloscopes such as the travelling-wave deflection type will require a different scheme; here again the avalanche transistor seems to be a probable solution.

Sweep generators

Early wideband oscilloscopes made use of timed gating circuits to turn on an rc charging circuit and to turn it off in the vicinity of full horizontal screen deflection. Today, however, with the use of a Miller integrator and feedback loop, the gating circuit need not be timed, since it is returned to the off position when the integrator reaches a preset voltage level corresponding to full screen deflection. The former circuits, therefore, required adjustment of the trigger acceptance controls each time a new sweep speed was selected. Now the gating circuit remains the same for all sweep speeds, adjustment need only be made initially and the trigger acceptance remains the same for all sweep speeds.

These circuits, together with the Schmitt trigger generator, lend themselves to such operator conveniences as automatic triggering and preset triggering controls.

Timing accuracy

The timing accuracy of oscilloscopes is a function of the linearity of the sweep generator and the sweep amplifier, and the agreement between the sets of rc time constants, one set for each speed, that govern the charging rate of the integrator. The combination of these factors lead to accuracies within 3% of full scale for most modern oscilloscopes.

Instruments have been on the market for some time with a horizontal slide-back feature, similar to the slide-back technique used with vertical amplifiers. It is also able to slide back information many screen diameters. This feature is called a delaying sweep; its slide-back control is calibrated to give 1,000 divisions per 10 cm of the delaying sweep. Times can therefore be read on the main sweep to 0.1% of the accuracy of the delaying sweep.

Precision timing is also possible to a degree with the use of known frequencies for comparison. It must be realized, however, that a visual observation on a scale of 10 cm is only slightly better than to within 1 mm. Thus, without resorting to slide-back techniques, readings on extremely high-speed signals can only be made to 1% by the use of time comparisons. Information with a duration of 1 usec and slower can be measured with greater accuracy using crystal techniques and counters.

Sweep amplifiers

The sweep amplifier serves two basic functions. One is to amplify the sweep generator sawtooth waveform so that the horizontal deflection plates receive the correct number of volts per unit time to give some fixed deflection

per unit time. The other is to provide a suitable input to the X-deflection plates when other than sawtooth waveforms are to be compared to the vertical information.

Wideband oscilloscopes generally have a limited-bandwidth horizontal amplifier. It is designed to amplify the sawtooth waveform linearly, but does not amplify sinusoidal waveforms linearly at higher speeds. A typical amplifier that can handle a 1-mc sawtooth waveform will have a sinusoidal bandwidth of only 600 kc for full-screen deflection.

A special oscilloscope is on the market that can display X and Y information identically up to 10 mc with less than 1 deg relative phase shift between the amplifiers, from dc up to 15 mc. This instrument is very useful in wideband modulation studies and flux-current studies of the better magnetic materials.

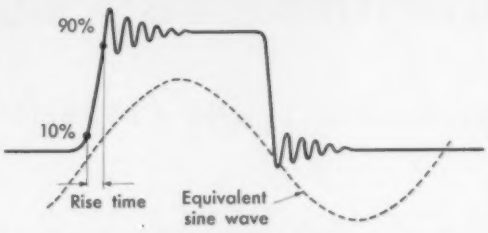


Fig. 5. Determination of bandwidth requirements

Application of the oscilloscope

It is necessary to analyze the measuring problem before selecting an oscilloscope to do the job. This involves knowing all aspects of the problem, including the impedances and output levels of any transducers employed, and the capabilities of the oscilloscopes under consideration.

The first point to be considered is bandwidth: any phenomenon needs adequate bandwidth to display the signal. As a rule of thumb, the required bandwidth should be at least 10 times the bandwidth of the frequency of which a half-cycle would have the same duration as a pulse to be observed. For example, a pulse of 1 usec duration would have an equivalent sine-wave (fig. 5) with a frequency of 0.5 mc. A bandwidth of 5 mc would be necessary to permit observation of harmonics up to the tenth order.

If the signal to be observed is a step function, the bandwidth requirement can be estimated by the following formula: Bandwidth in cps $=$ 0.035/Risetime in sec.

The oscilloscope must of course have sufficient sensitivity over the required bandwith. If the oscilloscope has bandwidth to spare and uses plug-in preamplifiers, it will be possible to select a plug-in with adequate gain and still maintain enough bandwidth to display the signal.

Convenience factors can now be considered. If the signal is continuous, a mono-accelerator crt will be adequate; if the signal is infrequent or a single shot, a post-accelerator tube will be better. Single-shot signals may also require such a feature as single sweep lockout to prevent more than one exposure if photography is used.

Conclusion

Because the oscilloscope does not suffer from form-factor it has been, for the last ten years, the most wideband, universal, amplitude-measuring device known. As accuracies are increased, it could become the most accurate wideband amplitude-measuring device in a general laboratory.

With new applications arising every day, the full utilization of the cathode ray oscilloscope has a long way to go. Chemical, medical and mechanical applications in particular are becoming an important part of the oscilloscope manufacturers' business, and more equipment will be designed to meet their requirements and using their units of measurement. END

Molecular electronics

Continued from page 35

When the ribbon-like crystals are cut into segments, only simple processing is needed to produce transistors at a yield very near 100%. By this method we have produced lengths of ribbon along which small multiple-junction subsystems are distributed, Fig. 5. Since these ribbons can easily be processed to become a long series of tiny amplifiers, it is not at all facetious to say that this ribbon can be snipped into lengths to give us amplifiers of whatever gain we desire.

A more recent and extremely significant achievement resulting from our research is that we have now discovered how to grow multizoned crystals as dendrites, directly from the furnace melt. We regard this development as a major event in new technology of molecular electronics. It makes available to us basic building blocks having at least three layers of zones and two interfaces. Thus it will no longer be necessary to perform many operations to create multizone elements.

In considering the implications of this basic method for crystal growth, one most interesting possibility is that it will prove practical to combine the ability to grow multizoned crystals with the ability to perform operations on the crystal at the time it is growing in the furnace. Admittedly, to achieve near-automatic production of semiconductor devices and molecular electronic function blocks is a long-range objective, but it is probable that we will eventually be able to "grow" from a pool of molten semiconductor materials some items of electronic equipment that today are of the order of complexity of radio receivers and amplifiers.

In three to five-years we expect to see molecular electronic concept widely applied in air/space electronic systems for such important applications as telemetering, fire control guidance, communications, counter weapons, and flight control systems. END

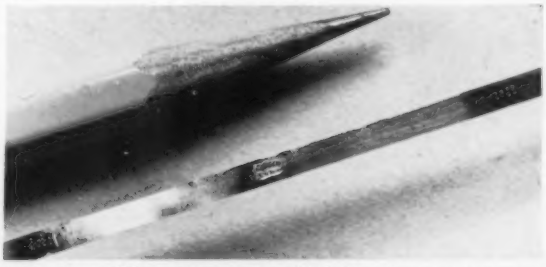


Fig. 6. Ribbon bearing multiple-junction systems on germanium crystal produced in the new dendrite process.

Cathode ray oscilloscopes

Available types classified by major characteristics

These listings of cathode ray oscilloscopes are based on information provided by the manufacturers or their Canadian representatives. Although every effort was made to obtain data on all known oscilloscopes, the lists should not be taken as all-inclusive. "ina"=information not available.

The lists are divided into four groups, according to the passband of the vertical amplifier channel: 1. less than 1 mc; 2. between 1 mc and 19 mc; 3. 10 mc or more; 4. special types for very high speed pulse work. Manufacturers are listed alphabetically in each group.

The first column gives the name and address of the manufacturer; where there is a Canadian representative, full address information is given only for the rep. An asterisk (*) means that the address has appeared earlier in the lists.

Model or type numbers may be followed by "Double beam," meaning a 'scope in which two separate vertical inputs can be displayed simultaneously by separate beams; or by "Dual trace," meaning a 'scope in which two vertical inputs are displayed alternately by means of a repetitive switching circuit. Cathode ray tube sizes are in the 3 in.-6 in. range, unless otherwise specified.

The frequency response of the vertical amplifier is given to the –3db point, unless otherwise specified. † signifies identical vertical and horizontal amplifiers. If the lower frequency is not dc, the vertical amplifier is ac-coupled only.

Sensitivity values are peak-to-peak, or dc, and are the maximum obtainable. They are not necessarily applicable at the maximum frequency shown in the previous column.

Group 1. Oscilloscopes with less than 1 mc bandwidth

Manufacturer	Model or Type No.	Frequency Response	Sensitivity	Accel. Pot'l.	Remarks
Cossor Instruments Ltd. E.M.I.-Cossor Electronics Ltd., 2005 MacKay St., Montreal; 3077 Bathurst St., Toronto 19.	1049 Mk III Double beam	A1: dc-200kc	33mv/cm	2kv	4kv accel. pot. available with reduced sens.
		A2: dc-400kc	1v/cm		A1 also has ac coupling
Dawe Instruments Ltd. E.M.I.-Cossor Electronics Ltd.*	720	5cps-50kc	30mv/cm	1.3kv	Portable, battery operated (internal 6v accumulator).
Allen B. DuMont Labs., Inc. Bayly Engineering Ltd., 5 First St., Ajax, Ont.; 48 Sparks St., Ottawa.	304-A, 304-AR	dc-200kc	10mv/cm	3kv	Also ac coupling.
	322-A Double beam	dc-200kc	10mv/cm	3kv	Also ac coupling.
	401-A, 401-AR	dc-100kc†	10mv/cm	3kv	Also ac coupling.
	403, 403-R	dc-300kc	100uv/cm	2.5kv	Also ac coupling.
	411, 411-R Double beam	dc-100kc†	100uv/cm	2.5kv	Also ac coupling; X-Y plotting.
EPR Special Products Corp. E. G. Lomas, 227 Laurier Ave. W., Ottawa 4.	918, 919 MAGNASCOPE 17" tube	dc-500kc (deflection at 500kc 4% of that at 1kc)	10mv/in	6kv	Also ac coupling. 919 has no internal sweep circuits.
Electronic Instrument Co., Inc. John R. Tilton Ltd., 51 McCormack St., Toronto 9.	425 (Kit or wired)	5cps-500kc (usable to 2.5mc)	140mv/in (not calibrated)	ina	Accessories: Calibrator 495; Electronic switch 488.
Feiler Engrg. & Mfg. Co., 8026 N. Monticello Ave., Chicago, Ill.	TS-7	20cps-100kc (—20%) (usable to 750kc)	1.4 v/in	ina	TS-7K is kit form.
Hartmann & Braun AG (Grundig) The J. W. Ellis Industries, 80 Richmond St. W., Toronto 1.	219	30cps-100kc	5.6mv/cm	ina	Two bandwidths. Electronic switch type
		20cps-3mc	112mv/cm		710 for viewing two signals.
Heath Co. Daystrom Ltd., 2 Raitherm Rd., Toronto 19.	OR-1	dc-200kc (—1db)†	0.1v/cm (not calibrated)	1.6kv	Also ac coupling. Available in kit form or wired.
Hewlett-Packard Co. Atlas Instrument Corp. Ltd., 50 Wingold Ave., Toronto 19; 3333 Cavendish Blvd., Montreal; 106-525 Seymour St., Vancouver 2.	120A, 120AR	dc-200kc	10mv/cm	2.5kv	Also ac coupling.
	122A, 122AR Dual trace	dc-200kc	10mv/cm	2.5kv	Also ac coupling.
	130B, 130BR	dc-300kc†	1mv/cm	3kv	Also ac coupling.
The Hickok Electrical Inst. Co. Stark Electronic Sales Co., Ajax, Ont.	387R	dc-500kc†	28mv/in	ina	Rack-mounting.
	685	dc-750kc†	56mv/in	ina	Also ac coupling.

Manufacturer	Model or Type No.	Frequency Response	Sensitivity	Accel. Pot'l.	Remarks
ITT Industrial Products Div. Standard Telephones & Cables Mfg. Co. (Canada) Ltd., 9600 St. Lawrence Blvd., Montreal 12. BAR-GRAPHS and 1700 Series have 17" tubes; 2100 Series have 21" tubes.	DC-40BG BAR-GRAPH	dc, or slowly varying dc.	0.2 mv/in approx.	ina	Displays up to 40 variables as vertical bars.
	AC-40BG BAR-GRAPH	10cps-50kc	3mv/in approx.	ina	As for DC-40BG.
	1735D, 2135D	dc-270kc†	10mv/in	6kv	Also ac coupling.
	1740D, 2140D	dc-100kc†	1mv/in	6kv	Also ac coupling.
	1770A	dc-110kc†	1v/in	6kv	Similar to 1735D, but no preamp. or time base.
	1770H	As for 1770A	100mv/in	6kv	Similar to 1770A, but with x10 preamp. added.
Marconi Instruments Ltd. Canadian Marconi Co., Commercial Prods. Div., 2442 Trenton Ave., Montreal 16.	TF 1159 17" tube	15cps-10kc (usable to 20kc)	4mv/cm	ina	
James Millen Mfg. Co., Inc. H. Roy Gray Co. Ltd., 44 Danforth Rd., Toronto 16; G. G. Smith, 4833 Westhill Ave., Montreal 29; J. C. Bastow, 10749-133 St., N. Surrey, B.C.	90915	dc-100kc (—10%)†	ina	ina	
	90923, 25	Low frequency	ina	ina	Rack-mounting.
	90902-05 Series	Basic rack-mounting oscilloscopes using various round and rectangular tubes. Amplifiers and sweep generators are in separate units 90921 and 90922.			
Philco Corp. of Canada Ltd., Accessory Division, Don Mills Rd., Don Mills, Ont.	S8200 3" tube	dc-750kc (—2db) dc-1mc (—6db) (not calibrated)	140mfv/in	ina	Amplifier 8300A extends response to 5mc.
Philips Electronics Industries Ltd., Research & Control Insts. Group, 116 Vanderhoof Ave., Toronto 17. Electronic switch GM 4580/02 for viewing two signals.	GM 5655/02	3cps-150kc	56mv/cm	ina	3cps-250kc (—6db)
	GM 5695	dc-200kc 1cps-100kc	0.5v/cm 14mv/cm	ina	
	GM 5666	dc-40kc dc-200kc	3mv/cm 350mv/cm	1.15kv	200kc amplifier in horizontal channel.
Rank Cintel Ltd. E.M.I.-Cossor Electronics Ltd.*	Demonstration oscilloscope	10cps-200kc	0.55v/in	ina	Beam switching included.
Ribet-Desjardins Electroline TV Equipment Inc., 5757 Decelles Ave., Montreal 26.	713 A/B	dc-500kc 5 amplifiers	3v/cm	ina	Beam switching included. Can be fitted with double beam tube.
Rycom Instruments Tele-Radio Systems Ltd., 3534 Dundas St. W., Toronto 9.	RM24 17" tube	dc-3.5kc Up to 24 channels	10mv/in	10kv	500uv/in with type 2440 preamplifier.
Sierra Electronic Corp. Atlas Instrument Corp. Ltd.*	218 Series	3cps-200kc (usable to 400kc)	1.4v/in	ina	Seven 218A-S scopes fit 218A-R 19" rack. Power supply is 218A-P
Southern Instruments Ltd. Conway Electronic Enterprises Reg'd., 1514 Eglinton Ave. W., Toronto 10.	M977 MINIRACK Double beam	Y: dc-180kc	30mv/cm	2kv	Two X amplifiers and two Y amplifiers. Y amplifiers can also be ac coupled.
		X: dc-340kc	120mv/cm		
Stark Electronic Insts. Ltd. Sales: Stark Electronic Sales Co., Ajax, Ont.	OSK-1 STARKIT	5cps-400kc (usable to 2.5 mc)	280mv/in	1.4kv	Available in kit form or wired.
	115	0.5cps-700kc	70mv/in	1.8kv	Usable to 2mc.
Sylvania Electric Products, Inc. Conway Electronic Ent. Reg'd.*	403 7" tube	dc-500kc (—2db)†	28mv/in	ina	Horizontal sensitivity 56mv/in.
Tektronix, Inc., 5 Finch Ave. E., Willowdale, Ont.	502 Double beam	dc-100kc (to 1mc at lower sens.)	200uv/cm	3kv	One Y amplifier can be switched to X plates.
Waterman Products Co., Inc. Aviation Electric Ltd., 200 Laurentian Blvd., Montreal 9.	S-11-A	dc-200kc (—2db)†	280mv/in	ina	Also ac coupling.
	S-14-A	dc-155kc (ina)†	28mv/in	ina	Also ac coupling.
	S-14-B	dc-700kc (—2db)	140mv/in	ina	Also ac coupling.
	S-15-A twin tubes	dc-180kc (—2db)	28mv/in	ina	Two X amplifiers and two Y amplifiers.
	S-17-A 3" x 1½" tube	dc-230kc (—6db)	10mv/div.	ina	Also ac coupling. Y signal can be switched to X channel.
Waters Manufacturing, Inc. M. J. Howard & Co. Ltd., 1168 Gertrude St., Ottawa 3.	7000-B	dc-100kc†	70mv/in	1.15kv	Rack-mounting.

Group 2. Oscilloscopes with bandwidth between 1 mc and 10 mc

Bach-Simpson Ltd., 1255 Brydges St., London, Ont.	2610	dc-6mc	9mv/cm	ina	Also ac coupling; calibration meter.
Cossor Instruments Ltd.*	1035 Mk III Double beam	A1: 5cps-5mc A2: 5cps-250kc	30mv/cm 3v/cm	2kv	10mv/cm to 1.5 mc.
	1058	dc-4mc	250mv/cm	1.8kv	Also ac coupling.

Manufacturer	Model or Type No.	Frequency Response	Sensitivity	Accel. Pot'l.	Remarks
Electronic Inst. Co., Inc.*	460	dc-4.5mc	70mv/in	ina	Also ac coupling.
Hartmann & Braun AG (Grundig)*	G4 6061	dc-4mc	20mv/cm	ina	Also ac coupling.
Heath Co.* Available in kit form or wired.	O-12	3cps-5mc (—5db)	70mv/in	1.2kv	
	OM-3	4cps-1.2mc	250mv/in	1.6kv	
	OP-1	dc-3.6mc	100mv/cm	2.3kv	Also ac coupling, 10mv/cm.
The Hickok Electrical Inst. Co.*	385 CSM	dc-2mc, or 4mc	75mv/in	ina	Also ac coupling; portable.
	1810	dc-4mc (—6db)	10mv/cm	3kv	Also ac coupling.
Jackson Electrical Inst. Co. Canadian Marconi Co., Elect. Tube & Comp. Div., 830 Bayview Ave., Toronto 17.	CRO-2	20cps-4.5mc (—1db)	50mv/in	ina	
James Millen Mfg. Co., Inc.*	None	10cps-1mc (ina)	ina	ina	Synchroscope-Oscilloscope.
PACO Electronics Co., Inc. Atlas Radio Corp. Ltd., 50 Wingold Ave., Toronto 19.	S-50	5cps-1.2mc	250mv/in	ina	Push-pull amplifiers; kit.
	S-55	dc-4.5mc	70mv/in	ina	Also ac coupling; kit.
Philco Corp. of Canada Ltd.*	S8202	10cps-1.6mc (—6db)	28mv/in	ina	Amplifier 8300A for 5mc.
Philips Electronics Ind. Ltd.*	GM 5650	dc-4mc	42mv/cm	ina	Usable to 10mc.
	GM 5654	1cps-3mc	28mv/cm	ina	Usable to 7mc.
	GM 5659	1cps-1mc (—6db)†	56mv/cm	ina	
Precision Apparatus Co., Inc. Atlas Radio Corp. Ltd.*	ES-500A	10cps-1mc	20mv/in	ina	
	ES-550	10cps-5mc	10mv/in	3kv	
The Range Electronics Co. Conway Electronic Ent. Reg'd.*	TRECOSCOPE	5cps-3.5mc	280mv/cm	900v	
		5cps-500kc	56mv/cm		
Ribet-Desjardins.*	255B	dc-4mc (—6db)	150mv/cm	ina	
	256A	dc-1mc (—6db)	15mv/cm	ina	Dual trace to 800kc.
	258A	50cps-1mc (—6db)	50mv/cm	ina	
	264C	10cps-2mc	6mv/cm	ina	Dual trace.
	267B	dc-1mc (—6db)	8mv/cm	ina	Also ac coupling.
	268A	50cps-1mc (—6db)	45mv/cm	ina	
The Solarton Electronic Group Ltd.	QD 910 Dual trace	dc-1mc†	10mv/cm	3kv	Infinite persistence using Hughes Memotron.
Instronics Ltd., P.O. Box 100, Stittsville, Ont.; 21 Benleigh Dr., Scarborough, Ont.	CD 1014 Double beam	dc-5mc	100mv/cm	1.4kv	Twin Y1 and Y2 amplifiers; single channel preamp.
Taylor Electrical Insts. Ltd. Conway Electronic Ent. Reg'd.*	31A, 32A	10cps-6mc	80mv/in	1.2kv	32A has 4cps-100kc time base; 31A has 10cps-500kc time base with single stroke trigger.
Tektronix, Inc.*	310A	dc-4mc	10mv/div.	1.8kv	Also ac coupling.
	321	dc-5mc	10mv/div.	4kv	Battery/mains portable.
	532	dc-5mc	10uv/cm	4kv	Plug-in units.
Telequipment Ltd. Canadian Electronics Ltd., 109 St. & 107 Ave., Edmonton 1; 334-4th Ave. S.E., Calgary.	SERVISCOPE	dc-6mc	100mv/cm	ina	
Trad Electronics Corp. Mel Sales Ltd., 1969 Avenue Rd., Toronto 12.	PO-400	10cps-6mc	280mv/in	ina	Equivalent to AN/USM-38
The Triplett Electrical Inst. Co. Len Finkler Ltd., 1794 Avenue Rd., Toronto 12.	3441-A	10cps-4.5mc (usable to 9mc)	28mv/in	ina	Calibrating meter.
Waterman Products Co., Inc.*	S-5-C	2cps-6mc	168mv/in	3kv	AN/USM-24C equiv.
	S-16-A	dc-5.7mc	100mv/cm	ina	Also ac coupling; 7mv/cm in HI SENS position.
	S-16-B	0.07us risetime	100mv/cm	ina	Digital data display unit.
	P1B2X10	dc-1mc	280mv/cm	ina	Panel-mounting.

Group 3. Oscilloscopes with 10 mc or more bandwidth

Cossor Instruments Ltd.*	1059 Double beam	1cps-10mc	100mv/cm	3kv or 6kv	10mv/cm to 200kc.
	1065	dc-11mc	250mv/cm	1.75kv	Accepts 1-mus pulses.

(Continued on page 54)

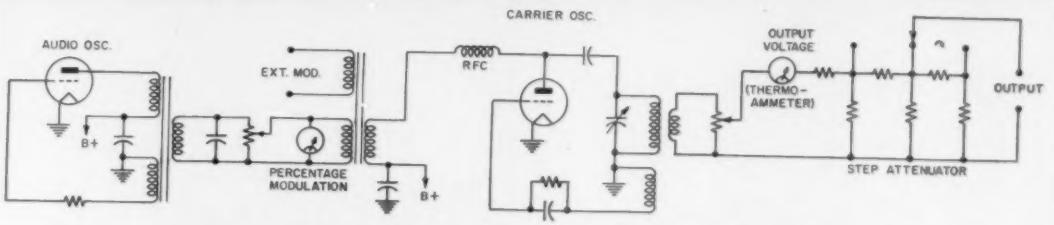


Fig. 1. Elementary schematic of an early standard-signal generator

Design trends increase versatility of standard-signal generators

W. F. BYERS, MEM.I.R.E., G. P. McCOUCH, SEN.MEM.I.R.E.*

Standard-signal generators are defined and their important characteristics examined. Current trends in the design of amplitude-modulated, pulse-modulated, frequency-modulated, and sweep-frequency generators are described. Methods of using signal generators in receiver testing and other applications are then detailed, with notes on additional factors to be considered when sweep-frequency techniques are used

The performance of early radio receivers was often specified in such vague terms as "coast-to-coast reception every night." The introduction of the first commercial Standard-Signal General in 1928 permitted quantitative measurements to be made of sensitivity and selectivity and, in effect, provided a convenient source of signals duplicating those received from broadcasting stations.[1] Fig. 1 shows an elementary schematic of an early standard-signal generator. It consisted of a carrier oscillator modulated by an audio oscillator. The percentage modulation and rf current into a step attenuator were monitored by calibrated thermocouple meters. Thirty percent amplitude modulation was obtainable. The step attenuator provided a range of output levels from 1 to 5,000 microvolts at a 10-ohm impedance level. (Higher levels were available at higher impedances.) Known carrier frequency, output voltage, output impedance and modulation depth were provided by these generators and they were therefore justifiably called "Standard-Signal Generators."

Standard-signal generators are still used basically for measuring gain or loss as a function of frequency. They are also frequently used as signal sources for impedance and other measurements over a wide range of frequencies. Many measurements are made with an unmodulated signal, but the inclusion of suitable modulation (amplitude, frequency or pulse) permits measurements involving detectors or demodulators. Point-by-point measurements can be used to determine the frequency characteristic of a device, but sweeping-frequency signal generators can be used to plot a graph quickly and automatically or to present a picture of an entire response.

Fig. 2 is a block diagram of a modern amplitude-modulated standard-signal generator; fig. 3 is a block diagram of a frequency-modulated signal generator; fig. 4 is a block diagram of a sweep-frequency signal generator; fig. 5 is a block diagram of a microwave pulse-modulated signal generator. The characteristics of these generators are discussed in some detail in the following paragraphs.

IMPORTANT CHARACTERISTICS

CONTROL AND INDICATION OF FREQUENCY

All standard-signal generators produce a carrier-frequency voltage of essentially sinusoidal waveform. The frequency is indicated directly on a dial or dials, with smooth continuous control a desirable feature. Most wide-frequency-range signal generators operating up to 500 mc use a self-excited LC oscillator as the carrier frequency source. A range selector switch is usually used to select the inductance, with continuous frequency coverage provided by a variable capacitor. From 500 mc to 11,000 mc coaxial lines are the preferred tuning element. Triode tubes are useful up to about 4,000 mc, and reflex klystrons from 800 to 35,000 mc. More recently several types of voltage-tunable tubes, such as carcinotrons, backward-wave oscillators, and voltage-tunable magnetrons have made wide-range, swept-frequency oscillators practical in the region of about 1,000 to 11,000 mc. Standard-signal generators using these oscillators are not yet generally available. Typical accuracy of the frequency calibration of standard-signal generators is ½ to 1%. Internal quartz-crystal-controlled calibrators provide check points of about ±0.01% accuracy, improving over-all accuracy to possibly ±0.1%. Typical drift rates after warm-up are of the order of 0.01% in ten minutes.

The trend is toward greater and greater selectivity in communications systems, to improve spectrum utilization and to make room for more channels. Probably a quartz-crystal-referenced automatic-frequency-control system will be used in future standard-signal generators to obtain the performance that will be required. Presently, standard-signal generators with good turning resolutions and low drift rates are being used with digital frequency meters (counters)

*General Radio Co., West Concord, Mass.

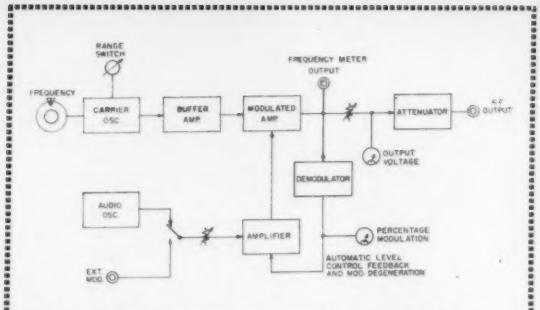


Fig. 2. Block diagram of a modern amplitude-modulated standard-signal generator

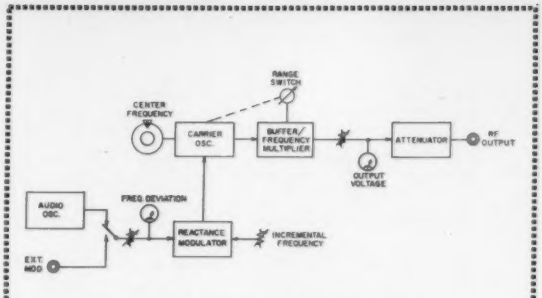


Fig. 3. Block diagram of a frequency-modulated signal generator

for the more critical applications. Most signal generators have dial drives which permit setting frequency to about 0.01%.

OUTPUT

Standard-signal generators are required to provide a wide range of output levels. Since a major use is receiver testing, extremely low output levels are necessary. It has been customary to calibrate the output in microvolts because in receiver testing it is usually desired to relate the sensitivity of the receiver to an electromagnetic field intensity expressed in microvolts per meter. The Institute of Radio Engineers has issued Standards on methods of testing radio receivers[2,3], which describe standard dummy antenna arrangements to be used. It is now common practice to provide, in addition to the microvolt calibration, calibration in dbm (decibels relative to one milliwatt), which is the power delivered to a rated load resistance. Some generators have decibel scales referred to other output levels than one milliwatt, such as 1 volt or 1 microvolt. Almost all modern standard-signal generators provide an output resistance that matches the characteristic impedance of standard coaxial cables, 50 ohms being a common value. This permits a reasonable length of cable to be used between the output terminals of the generator and the device under test without alteration of the effective generator voltage and impedance of the source. The output of some signal generators is calibrated in open-circuit microvolts or microvolts behind the standard output impedance, so that one can consider the output of system to be that of the classical zero impedance voltage generator in series with a stated output resistance. The voltage across any terminating impedance can then be readily determined.[4]

An output calibration in microvolts produced across a standard termination is also frequently used on standard-signal generators. This implies that the standard termination should always be provided by the user. When the internal signal generator resistance is equal to the standard termination resistance, the voltage indicated by the signal generator calibrated in this manner is just one half of the open-circuit value. It is essential that the user know which method of calibration was used for the instrument he is using, as otherwise he may readily misinterpret the output voltage indication of the generator by a factor of 2:1.

In the standard-signal generator, the output system consists of a relatively high-level source followed by a resistance-ladder attenuator, or a variable mutual inductance or capacitance attenuator.[5] Means are usually provided to adjust the level at the monitoring point to some predetermined value indicated by a monitoring meter. This permits the level to be monitored at high levels where it is possible to get reasonable accuracy and provides a wide range of levels from a single source. Excellent shielding, of course, is required to confine the high-level energy when the attenuator is set for minimum output. Some presently available standard-signal generators provide outputs into matched loads from 10^{-15} watts (0.446 microvolts behind 50 ohms) to greater than 10^{-1} watts (4.46 volts behind 50 ohms), a range in excess of 140 db. A more common upper limit of output is in the vicinity of 10^{-3} watt. Typical overall errors in output level, including impedance errors, are of the order of ± 1 db up to a few hundred megacycles. At higher frequencies, the errors increase, owing principally to impedance mismatches; ± 2 db error is typical in the 1,000-mc to 10,000-mc region.

The trend is to extend the range of available levels from signal generators upward to perhaps several watts and decrease the minimum level provided. Some improvement in accuracy of level should also be possible, but the presence of harmonic output and connection errors offer serious problems. Automatic level control is provided in some standard-signal generators; this operates to keep a pre-set output level constant over long periods of time and with changes in frequency or load as well as of temperature and supply voltage.

SPURIOUS OUTPUT FREQUENCIES

One important reason for the provision of high-level output is to permit measurement of the ability of receivers or devices having frequency-selective filters to reject signals outside of their normal pass bands. The presence of spurious signals in the output of the signal generator gives anomalous results since such signals may fall within the maximum response range of the network under test.

It is often desired to measure rejection ratios of 60 to 120 db. The most serious spurious outputs from the usual standard-signal generator are at carrier-frequency harmonic or subharmonic frequencies. These may be only 30 to 40 db below the carrier level. Noise and hum modulation of the carrier, both am and fm, produce spurious sidebands which may extend a considerable distance either side of the carrier. These components may be 60 db or more below the carrier level in typical generators, but even this small spurious output may be too great for some applications. It is expected that much attention will be devoted to the reduction of spurious output in the design of new signal generators.

MODULATION

The two basic types of modulation are amplitude modulation and frequency modulation. It is usually desirable to produce only one type of modulation at a time without

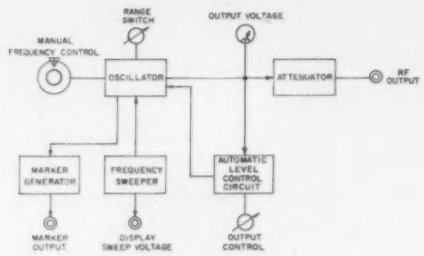


Fig. 4. Block diagram of a sweep-frequency signal generator

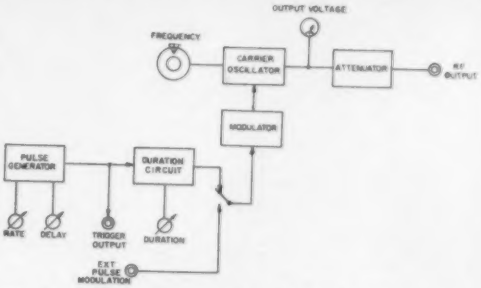


Fig. 5. Block diagram of a microwave pulse-modulated signal generator

any accompanying or "incidental" modulation of the other type being introduced.

Amplitude modulation

Linear amplitude modulation is commonly provided for carrier frequencies below 1,000 mc. At least 80% modulation over a modulation frequency range of 30 cps to 15 kc using an external modulating source is possible with most generators. Internal modulating sources provide a choice of modulating frequencies, 400 and 1,000 cps being commonly available. The envelope distortion is usually under 5% at 80% modulation, and up to 100% modulation can often be obtained at somewhat higher distortion. The residual noise modulation is usually under 0.1%. Incidental frequency modulation less than 0.003% of the carrier frequency has been obtained in some commercial instruments, but values up to 0.03% at some carrier frequencies are typical of many generators. The percentage of modulation is indicated on a meter and can be set for any value desired. Actual modulation percentage within ±10% of the indicated value is typical. The trend is to reduce the envelope distortion and incidental frequency modulation as well as the residual noise modulation. The accuracy of the modulation indicator will probably also be improved.

Pulse modulation

Pulse modulation is a particular form of amplitude modulation. The rise and decay times of pulses provided by usual types of signal generators operating in the hf and uhf regions are quite appreciable, owing to bandwidth limitations in circuits of adequate quality to provide reasonable rejection of spurious outputs. Consequently, most present signal generators providing good pulse modulation operate above 500 mc; the majority of these are modulated oscillators. The modulation of an oscillator provides excellent on-off ratios but there is usually difficulty with delay in the starting of the pulse and little control of the pulse shape. Better pulse envelopes can be obtained by the modulation of an amplifier or the use of a loss modulator at the output[6], but high on-off ratios or high output levels are difficult to achieve by these methods. Typical pulsed signal generators have internal modulating sources that provide pulse durations of 1 to 10 microseconds, repetition rates of 40 to 4,000 pulses per second, and envelope rise time of the order of 0.1 microseconds. The trend seems to be toward providing for linear modulation so that shaped pulses can be applied and reproduced on the carrier envelope. Good on-off ratios will have to be provided, probably better than 100 db, as well as wide modulation bandwidths, perhaps 100 mc or more at the higher carrier frequencies.

Square-wave modulation is a particular form of pulse modulation, for which the duty ratio is 50%. It is commonly provided where the generator is a modulated oscillator (usually at uhf and higher frequencies), both because it is easier to produce than linear am and because it suffers less from the incidental fm which is so serious with sinusoidal fm of an oscillator.

Frequency modulation

Frequency modulation is useful not only for testing frequency-modulation devices, but in a system for automatically displaying the response of a network or device as a function of frequency. Most frequency-modulated signal generators provide up to ±200 kc frequency deviation over a modulating frequency range of 50 cps to 15 kc. A modulating frequency range extending to 200 kc is sometimes provided for testing systems using subcarrier multiplexing. Typical modulation distortion is of the order of 2% for ±75 kc deviation, with incidental amplitude modulation less than 5%. Frequency deviation is usually indicated on a meter with an accuracy of better than 10% of indicated value, and is continually adjustable from the residual level to the maximum provided.

There is need for better linearity of modulation with large deviation and modulating frequencies, better phase linearity versus modulating frequency, and more accurate carrier frequencies for some applications. These requirements will certainly influence the design of future general-purpose frequency-modulation signal generators.

Sweep-frequency generators

Sweep-frequency signal generators are a special class of frequency-modulated signal generators specifically designed to provide automatic visual presentation of the frequency response of devices and networks. They provide larger frequency deviation than the usual frequency modulated signal generator, but normally at only low, and possibly fixed, sweep rates. Frequency deviation about the centre frequency as great as ±40% of this frequency is not uncommon. A voltage varying in synchronism with the frequency variation is usually provided for horizontal deflection of a cathode-ray oscilloscope. The amplitude variable is usually obtained from a detector at the output of the device under test and presented as a vertical deflection on the oscilloscope. A graph of the frequency response of the device is thereby obtained. Some kind of frequency-identifying markers are usually superimposed on the display to provide a calibration of the frequency scale. The source of these markers may be in a separate device or included in the sweep-frequency generator.

Low sweep rates are essential to avoid distortion of the response.[7] For minimizing display flicker on a normal

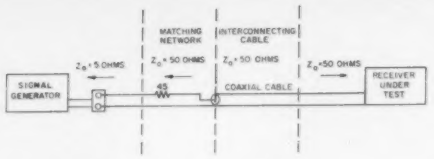


Fig. 6. Connections from 5-ohm signal generator to 50-ohm receiver

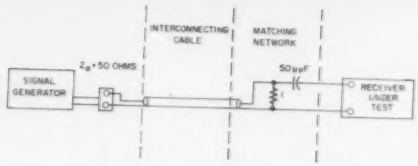


Fig. 7. Connections from 50-ohm signal generator to aircraft receiver

cathode-ray oscilloscope, sweep rates in excess of 20 per second are desirable and can be used for the wider bandwidth responses. For narrow band or steep-sided responses, such as are obtained with electro-mechanical filters, sweep rates as low as fractions of a cycle per second may be necessary to avoid distortion, so that a long-persistence oscilloscope or an X-Y plotter must be used with a sweep-frequency generator capable of sweeping at this low rate. Mechanical drives can often be applied to the manual frequency control of ordinary standard-signal generators for slow sweeping. Typical total sweep widths of 20 mc or maximum to minimum frequency ratios of 1.5 to 1 are provided by available sweep-frequency signal generators. Typical sweep rates are 20 to 60 per second. Of particular importance is the constancy of rf output over the range of frequencies swept. A total variation of less than 1 db is achieved with most generators and a more desirable performance of less than 0.2-db variation obtained with some. Good linearity of the frequency scale on the display is important to show a true picture of the response. Deviations from a linear presentation of less than 10% of the width of the display are typical. Quartz-controlled markers are accurate to better than 0.01% frequency. Other types of markers may be accurate to better than 0.5% of absolute frequency.

The trend is to improve the accuracy and convenience of sweep-frequency generators so that they can be used for more critical applications. Some sweep generators of rather poor performance have destroyed the confidence of many users in sweep measurements. It will be difficult for sweep techniques to be applied to all measurements that can be made point by point, particularly those requiring amplitude ratios of 100 db and more to be displayed, but better sweep generators and display systems will permit greater application of this time-saving technique. For some purposes completely automated systems using signal generators are necessary and perhaps even general purpose instruments of the future will include provisions for this type of operation.

APPLICATIONS

RECEIVER TESTING

Tests commonly required in the course of development of a modern radio receiver illustrate most of the important applications of a standard-signal generator. In order to interpret the results of such tests correctly, the engineer must be constantly alert to the limitations inherent in the signal generator and its method of connection to the device under test, and also to the characteristic limitations of the detector which may be part of the device under test or an auxiliary unit. In this section only measurements made by point by point techniques will be considered.

Sensitivity and spurious response measurements

Consider the precautions necessary in measuring the sensitivity of an am-hf aircraft communications receiver. The problem is not to measure noise figure, but to determine how many microvolts are required to produce a certain signal-to-noise ratio under specified conditions of modulation. Before the measurement is attempted, it is necessary to establish connections between the generator and receiver which will produce the required driving impedance conditions. If the signal generator has a 50-ohm output impedance and the receiver is designed to have a 50-ohm input impedance, a simple 50-ohm coaxial cable connection is all that is required. But let us suppose the signal generator has only a very low output impedance such as 5 ohms. Then it is important to add a 45-ohm series resistor at the generator terminal before connecting the 50-ohm cable to the receiver (fig. 6). Usually such a generator is calibrated in terms of output voltage behind its 5-ohm termination (i.e., open-circuit voltage), so that the signal generator output will still be as shown by the calibration, but behind 50 ohms. Note that the open-circuit generator voltage will be twice the voltage actually appearing at the receiver terminals if the receiver input impedance really is 50 ohms. The open circuit microvolts are sometimes referred to as "hard" microvolts because it is more difficult to realize a sensitivity corresponding to a given number of open-circuit microvolts than one corresponding to the same microvolts across the receiver input terminals.

Next suppose that the receiver is designed for use with a short wire antenna having a series equivalent circuit of a 1-ohm resistance in series with 50 pf of capacitance. Clearly a 50-ohm signal generator does not properly simulate the antenna, and, in fact, the addition of the 50-ohm impedance to the receiver input circuit directly could well both de-tune and de-grade the input circuit quality so seriously that the apparent receiver sensitivity would be very poor. In this case the signal generator should feed a coupling network or dummy antenna consisting of a 1-ohm shunt resistor followed by the series 50 pf capacitor feeding the receiver (fig. 7). It is important in this case to locate these elements right at the receiver input terminal, and then to use 50-ohm cable from the coupling network back to the 50-ohm signal generator. It is now necessary to calculate the equivalent generator voltage behind the new 1-ohm output impedance. This will be 1/51 x the open circuit voltage of the generator. If the generator is calibrated in terms of voltage supplied to a matched load, the open circuit generator voltage is twice the calibrated value. It is important to know how the generator is calibrated in order to avoid the possible error of 2:1 in generator voltage. The specification of sensitivity should clearly state whether the voltage is measured across the receiver terminals or, preferably, behind a specified source impedance.

Once suitable input connections have been established

between the generator and the receiver, a measurement of sensitivity is usually made by establishing the minimum signal-input level for which the ratio of receiver output with modulation on the input signal to receiver output in the absence of modulation reaches some predetermined value, such as 6 db. Clearly the observed sensitivity as determined by this test depends directly on the accuracy with which the percentage of modulation is determined. Thus, specification of the accuracy to which sensitivity can be determined depends not only on the basic accuracy of calibration of the signal generator output system, but also on the accuracy of modulation calibration.

The standard test for quieting sensitivity of an fm receiver is entirely analogous to the test for sensitivity of an am receiver. In this case, the sensitivity is the input carrier level which produces a 30-db ratio between receiver output with 30% modulation at 400 cps and noise output with the same carrier input but unmodulated.[3]

Probably the most serious error in sensitivity measurement can occur if the leakage of the signal generator is great enough to feed an appreciable signal by any one of several routes into the receiver. This is generally not a problem if it is possible to reduce the generator output until no signal can be detected by the receiver. Another parameter which must be considered is the modulation frequency. Some receivers may have deliberately poor audio-frequency response at 400 cps, whereas with receivers operating below 500 kc, it is common for the i-f selectivity to be such as to attenuate 1,000-cps sidebands significantly, thereby reducing the apparent depth of modulation at 1,000 cps as compared to 400 cps. There are also observational errors, but these can be minimized by taking the average of several determinations of sensitivity.

Another measurement for which accuracy of calibration of modulation percentage is important is the determination of performance of noise limiters. These are frequently required to start limiting at positive modulation peaks of some predetermined value such as 80%.

Not only is sensitivity to the desired signal important, but so also is sensitivity to undesired potential interference. The ratio of signal amplitude required at an undesired frequency to that required at the desired frequency to obtain reference output is the rejection ratio, usually expressed in decibels. The spurious signal which first comes to mind is the image in a superheterodyne receiver, located twice the i-f frequency away from the desired signal. The next most serious interference occurs at a frequency equal to the signal frequency ± one half the i-f frequency. The sign is + if the signal is below the oscillator, and — if above. This frequency is only ¼ as far from the signal frequency as is the image frequency. Hence this interference is usually not very strongly rejected by the preselector tuned circuits (fig. 8). Both it and the local-oscillator signal generate second harmonics in the mixer which beat together to provide output at the intermediate frequency. A similar process involving other higher order harmonics can provide a whole series of other spurious responses whose seriousness needs to be assessed. Two other types of spurious response are common: the first is direct i-f break-through due to inadequate rejection by the preselector tuned circuits; the second is a feedback problem internal to the receiver. If appreciable high-level i-f output can get back to the receiver input, then when the receiver is tuned to carrier frequencies which are harmonics of the i-f, birdies will be heard as a signal generator is tuned through. Due to receiver automatic gain control, the i-f output level is almost independent of signal input level, so the ratio of feedback signal to desired input signal is greatest for weak signal inputs. In consequence, receiver sensitivity may be degraded significantly at signal frequencies which are harmonics of the intermediate frequency.

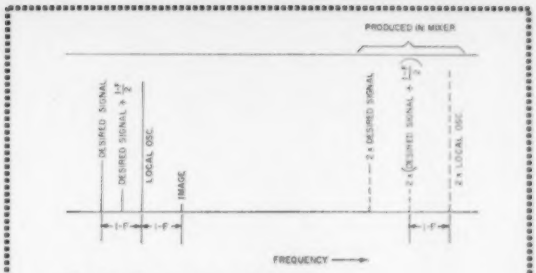


Fig. 8. Frequency relationships in superheterodyne receiver

Selectivity

Another category of measurement in which both output-calibration accuracy and frequency-calibration accuracy are important is in the measurement of selectivity. These measurements commonly require subtraction of two frequencies which are each large compared to their difference. Whereas the absolute frequencies may be of only limited importance, the differences must be determined with considerable accuracy. This can frequently be accomplished by care in always approaching all frequency settings from the same direction to overcome backlash limitations of the signal generator frequency control mechanism, provided that the signal frequency is not drifting significantly compared to the difference frequencies under consideration. The provision of vernier dial and interpolation scales on the signal generator can be of great assistance in making selectivity measurements.

The use of a frequency counter to establish the frequencies to substantially greater accuracy than can be determined from direct dial readings is very helpful, but several details must be considered. Usually the counter requires a fairly large signal (a few tenths of a volt) to operate it, so that the signal generator output attenuator must be reset and the output cable transferred from the receiver to the counter to make the counter operate, unless the signal generator has a separate high-level output available. It is important to be sure that these changes do not significantly affect the signal-generator frequency. In addition, counters are not generally well-shielded devices, so that even if a separate high-level output is available from the signal generator, it will be necessary to disable this except when counter readings are being taken in order to avoid leakage problems. Counters also have an unpleasant habit of radiating serious amounts of rf owing to the many steep wavefront switching operations which are inherent in their operation. These may introduce large amounts of noise into the receiver unless the counter is disabled when making the actual measurement on the receiver.

A few particular points on the selectivity curve are usually of special interest. Where a flat-topped pass band is desired, the points which are 1 db, 2 db or 3 db down from maximum response are commonly of interest as delineating the limits of the desired pass band. Usually these points are determined by a substitution technique which eliminates characteristics of the receiver detector from consideration. The receiver agc system is disabled in making these tests, and the signal generator is modulated, usually 30% at 400 or 1,000 cps for am receivers. The signal generator is set to produce some arbitrary reference output from the receiver at the frequency of maximum response,

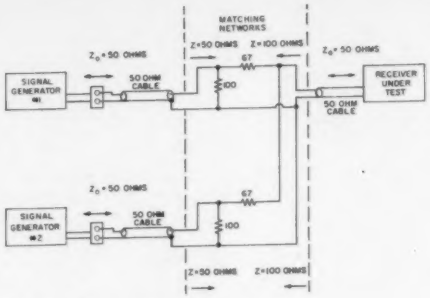


Fig. 9a. Connections for measurement of cross modulation

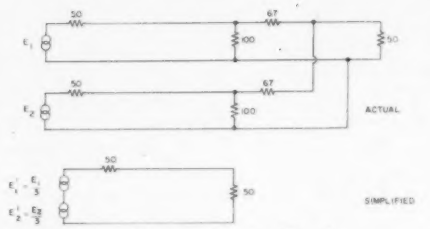


Fig. 9b. Equivalent circuits for Fig. 9a

then the attenuator of the signal generator is reset to increase its output by the amount of insertion loss for which a frequency reading is desired. The signal generator is then retuned successively on each side of the maximum response point until reference receiver output is restored, and frequency readings are taken. For the small differences in output required for measurements near the pass band, greater accuracy is usually obtained by observing changes in output readings on the monitor meter of the generator than by noting differences in setting of a piston attenuator. The user should be careful to assure himself that changes in monitor meter readings are not accompanied by significant reactions on the signal generator frequency.

A common measure of selectivity is the ratio of bandwidths at 60 db down from maximum response to that at 6 db down, usually referred to as shape factor. The 60 db-down points are particularly easy to measure when the signal generator has a resistive step attenuator, because the precision of setting or reading required when using a piston attenuator is not needed. Of course, the user is at the mercy of the accuracy built into either type of attenuator by the manufacturer of the signal generator. Fortunately, the rate of change of attenuation is usually so steep at 60 db down on the receiver pass band that large errors in bandwidth do not commonly occur.

Selectivity measurements should be made with signal generator frequencies centred at various points in the tuning range of the receiver in addition to making an i-f selectivity measurement. The rf tuned circuits may sharpen the selectivity provided by the i-f amplifier alone, especially at the lower carrier frequencies. To measure the i-f selectivity characteristic, it is important to couple the signal generator into the receiver properly in such a manner as not to upset the i-f alignment. This can best be accomplished by feeding the signal generator output directly to the receiver mixer signal input. It may be necessary to disconnect this point from the tuned circuits to which it is usually attached, but if the signal generator has adequate output to overcome the shunting effect of this circuit, the change in connection is not usually required. The shunting effect can be minimized in capacitor-tuned circuits by tuning to the high-frequency end of the lowest band of the receiver, while on permeability-tuned circuits, tuning should be to the low-frequency end.

Cross modulation

Measurement of cross-modulation characteristics requires great care indeed if reliable results are to be obtained. Two signal generators are connected to the receiver input through suitable matching and isolating networks (fig. 9). One generator is tuned to the desired carrier frequency, and adjusted to the level at which it is desired to conduct the test. After noting the reference audio output with some standard modulation such as 30% at 1,000 cps, the modulation is turned off. The second generator is modulated with standard modulation, and tuned to various frequencies outside the nominal receiver pass band. The level of this second generator is increased until reference audio output is obtained at each test frequency. The results of such a test depend greatly on the specified test conditions, but frequently show that adjacent-channel rejection is substantially less than that to be expected on the basis of i-f selectivity alone. For results to be significant, it is important to provide sufficient isolation between the generators so that no significant intermodulation occurs within either generator. For most measurements, ample isolation is provided by the difference in output level required from the two generators.

Fidelity and distortion measurements

Measurement of the audio amplifier characteristics of a receiver fails to provide an adequate check of over-all fidelity or distortion performance, both because of difficulties in the receiver detector, and because of possible sideband clipping by the radio-frequency tuned circuits. Unfortunately, the receiver is only one of the distortion-producing elements in the chain between a modulating signal applied to the signal generator, and the output from the receiver. The signal-generator audio system is never perfect, either in frequency response or in distortion characteristics, and even if it were, the modulation process itself is not perfect. Two difficulties are particularly worthy of mention. The first is sideband clipping due to selectivity of the tuned circuits in the signal generator. This can occur in either am or fm signal generators. It is most serious at low-carrier frequencies, and can limit the modulation percentage attainable. The second is the creation of fm incidental to the process of generating am, or in the case of an fm generator, the creation of incidental am. The presence of incidental modulation in addition to the desired modulation distorts the sideband structure and hence introduces distortion in the modulation recovered by the receiver.

Am can be produced virtually free of fm by means of loss modulators, such as diodes or ferrite devices, but these are often severely limited as far as linearity, modulation depth, and signal handling ability are concerned.

As the quality of the receiver performance improves with regard to distortion, the importance of defects in the signal generator becomes even more serious. A clear understanding of the limitations of the signal generator itself is essential to proper interpretation of measured fidelity and distortion characteristics.

MISCELLANEOUS APPLICATIONS

The standard-signal generator has been applied to many other purposes beside receiver testing, yet the methods and

problems in such areas as insertion loss measurements on filters or attenuators are no different from those encountered in corresponding receiver measurements.

VSWR measurement

The use of a square-wave modulated signal generator to make slotted-line measurements is convenient. The use of square-wave modulation minimizes incidental fm which might obscure the minima of the standing-wave pattern, and permits use of a sensitive, tuned, audio amplifier following the detector. The gain in sensitivity permits reduced coupling of the detector to the line, and hence improved accuracy. Where moderate values of vswr are encountered, the attenuator of the signal generator can be used to produce the same output from the detector on the slotted line at maximum and minimum voltage points. The ratio of attenuator settings for the two points is the vswr, and is particularly easily determined where a decibel scale is part of the attenuator calibrating system.

Local oscillator and pump applications

In some cases, such as the use in place of a receiver local oscillator or transmitter vfo, the modulation features of the signal generator are not used. Nevertheless, there is usually some residual hum modulation at harmonics of the power line frequency which can cause trouble in some measurements. If, for example, the signal generator is used as a local oscillator to beat down a signal under test which is to be examined for spurious noise or fm, it is important that the generator be better in these regards than the device under test. One way of separating out the effects of power frequency residual fm in the generator from that in the device under test is to operate the latter from a different supply frequency, such as 70 cps. The recovered signal at 70 cps and its harmonics can be separated from that at 60 cps by means of a wave analyzer. In the case of broadband residual noise modulation, such as is found on klystron oscillator generators, it is not always possible to get around the generator noise, although the use of a balanced mixer is of some help. The use of triode oscillators with well-filtered dc on the tube heater as well as on the plate is most helpful in such critical applications as the pump for a parametric amplifier.

SWEEP-FREQUENCY MEASUREMENTS

In addition to the precautions outlined in the preceding sections, there are additional factors to be considered when sweep-frequency techniques are used.

Frequency-exploration rate

When a signal with a rapidly changing frequency is applied to a frequency selective network, transients are produced which do not occur with constant frequency signals. If the rate of frequency variation is sufficiently low, the magnitudes of the transients become negligible in a display of the response. If the sweep rate can be reduced by a factor of 3 without changing the picture of the response presented, this condition is satisfied. If the sweep generator does not provide for a large reduction of sweep rate, point-by-point checks should be made to see if a true picture of the response is being obtained.

Output level variation

Unless a ratio-type of detection system is used, the output of the sweep-frequency generator must be constant over the band of frequencies swept. The sweep display system can usually be connected to the output of the signal generator to check the flatness of output voltage over the sweep width to evaluate errors from this source.

Response detector errors

The device under test may include a detector which provides a voltage which is displayed as the amplitude variable. If such a detector does not exist, an external detector must be used; it should have a flat frequency response over the band of frequencies swept so as not to influence the characteristic presented. Resonances in the response detector can greatly accentuate any harmonics present and distort the presentation. The speed of response of the detector should be as high as possible so that no unnecessary limitation is placed on the frequency-exploration rate. The checks described under frequency-exploration rate and output level variations include effects due to the detector.

Dynamic range of the display

The usual sweep-frequency signal generator provides a constant signal level for the device under test over the range of frequencies swept. With a linear detector, the practical amplitude range of the display is 40 db or less. In most active devices, the dynamic range in the absence of automatic gain control is limited so that the amplitude of input signals at the centre of the pass band must be severely restricted if overload is to be avoided. Clearly, if the input signal power may not exceed the equivalent noise input power by more than 40 db, it is impossible to use a constant amplitude input signal to measure a rejection characteristic at 100 db down from the maximum output, since the resultant output would be 60 db below the noise level.

A sweep system using a servo-controlled attenuator for maintenance of a constant output level from the device under test would be ideal for producing a display covering these wide amplitude ranges. The attenuator position would be presented as the amplitude variable on the sweep display and the dynamic range would only be limited by the range of the attenuator.

With presently available sweep-frequency generators and linear detectors, the following technique can often be used. The maximum part of the response is first determined by setting the generator level to a value which will not overload the device under test. The level is then increased enough to present the edges of the response (lower level portions), even though overloading occurs during other portions of the display. If the recovery from overload is sufficiently rapid, the lower level portions will be accurately presented and a picture of the entire response can be obtained by combining two or more displays. Reduction of the sweep rate or a few point-by-point measurements will show if an accurate presentation is obtained by this technique. END

REFERENCES:

1. *"Rating of Radio Receivers," General Radio EXPERIMETER, Nov. 1928.*
2. *Standards on Radio Receivers: Methods of Testing Amplitude Modulation Receivers, IRE, 1948.*
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4. *Arnold Peterson, "Output Systems of Signal Generators," General Radio EXPERIMENTER, June 1946.*
5. *F. E. Terman, "Signal-Generator Attenuators," Radio Engineers Handbook, sec. 13, para. 37, p. 980, McGraw-Hill Book Co., 1943.*
6. *W. F. Byers, "A Balanced Modulator for Pulse Applications," General Radio EXPERIMENTER, April 1954.*
7. *J. Marique, "The Response of RLC Resonant Circuits to EMF of Sawtooth Varying Frequency," Proc. IRE, vol. 40, Aug. 1952.*

Standard-signal generators

Available types classified by major characteristics

Manufacturer and Canadian Representative	Model or Type No.	Carrier Frequency	Modulation					Remarks
			am	fm	cw	pulse	sweep	
Adler Electronics, Inc. Instronics Ltd., Box 100, Stittsville, Ont.	TS-155E/UP	2700-3400mc	..	..	..	√	..	
	TS-497B/URR	2-400mc	√	..	..	..	..	Ext. pulse modulation also.
Advance Components Ltd. Conway Electronic Enterprises Reg'd., 1514 Eglinton Ave. W., Toronto 10, Ont.	B4	30kc-80mc	√	..	..	..	..	
	C2	30kc-30mc	√	..	..	..	..	
	E2, P1	100kc-100mc	√	..	..	..	..	
	62	150kc-220mc	√	..	..	..	..	
	D1/D	10mc-300mc	√	..	..	√	..	
	D1P/2	2mc-190mc	√	..	..	..	..	
	Q1	7.5mc-250mc	√	..	..	√	..	
	63	7.5mc-230mc	√	√	..	..	..	
Alfred Electronics, 897 Commercial St., Palo Alto, California.	601 series	1-18kmc	√	..	√	√	√	
	621-6 series	1-18kmc	√	√	√	√	√	Has frequency markers
	6001-4 series	1-11kmc	√	..	√	√	√	
American Electronic Labs., Inc. Conway Electronic Ent. Reg'd.,	138	1cps-250kc	..	..	..	..	..	Pulse generator.
AVO Ltd. R. H. Nichols Ltd., Box 500, Downsview, Ont.	111	150kc-220mc	..	√	√	..	..	
	378	2mc-225mc	√	..	..	√	..	Sine and square wave.
	TFM	5mc-220mc	√	√	√	√	..	Sine and square wave.
BJ Electronics, 3300 Newport Blvd., Santa Ana, California.	20	85kc-40mc	√	..	..	..	..	
	30A	40mc-400mc	√	..	..	..	..	
	75A	10mc-440mc	√	√	√	√	√	
	80	2700mc-3000mc	..	..	..	√	..	
	82 series	20mc-1000mc	√	..	√	√	..	Plug-in units.
Beckman Instruments Inc., Berkeley Division. R-O-R Associates Ltd., 1470 Don Mills Rd., Don Mills, Ont.	903		..	..	..	..	..	Pulse generator 0.15 to 1.8 usec.
	4904		..	..	..	..	..	Pulse generator 0.3 to 10 usec.
Boonton Radio Corp. Bayly Engineering Ltd., 5 First St., Ajax, Ont.; 48 Sparks St., Ottawa.	202-E	54mc-216mc	√	√	√	√	..	
	202-G	195mc-270mc	√	√	√	√	..	
	225-A	10mc-500mc	√	√	√	√	..	
	240-A	4.5mc-120mc	√	..	√	..	√	
British Physical Laboratories. Conway Electronic Ent. Reg'd.	PG 712A (and B) Mk II		..	..	..	..	..	Pulse and square wave generator 0.04-1 usec.
A/S Bruel & Kjaer. R-O-R Associates Ltd., 1470 Don Mills Rd., Don Mills, Ont.	1013	500cps-200kc	..	..	..	..	√	
	1014	50cps-20kc	..	..	..	..	√	
	1017	2-2000cps	..	..	√	..	..	External sweep.
The Clough-Brengle Company. Hackbusch Electronics Ltd., 23 Primrose Ave., Toronto 4.	182-A	25-15000cps	..	..	√	..	√	External sweep.
	282-A	50cps-30kc	..	..	√	..	√	
	299-A	100kc-32mc	√	..	..	..	..	
	405	20cps-50kc	..	..	..	..	√	Manual band spread
	555	10mc-490mc	√	..	√	..	..	
	603	20-30; 40-60mc	..	..	√	..	..	I-F sweep generator.
Cossor Instruments Ltd. E.M.I.-Cossor Electronics Ltd., 2005 MacKay St., Montreal; 3077 Bathurst St., Toronto 19.	1323A	5mc-225mc	..	√	..	..	√	
	1324	7.5-27.5mc & 87.5-107.5mc	..	√	..	..	..	
Dawe Instruments Limited. E.M.I.-Cossor Electronics Ltd.	443	20cps-20kc	..	..	..	..	√	
	444	5cps-5kc	..	..	..	..	√	
Donner Scientific Company. Instronics Ltd., Box 100, Stittsville, Ont.;	15	0.01-1000cps	..	..	√	..	..	Sine and square wave
	1202	1cps-1mc	..	..	√	..	..	
Allen B. Du Mont Labs., Inc. Bayly Engineering Ltd., 5 First St., Ajax, Ont.;	404		..	..	..	..	..	Pulse generator, single pulse to 100,000 pps.

Manufacturer and Canadian Representative	Model or Type No.	Carrier Frequency	Modulation: am	fm	cw	pulse	sweep	Remarks
Dymec, Inc. Atlas Instrument Corp. Ltd., 50 Wingold Ave., Toronto 19, Ont.	DY-5003	8.5-10kmc	..	√	..	√	..	Similar to Hewlett-Packard 624C.
	DY-5381	8.5-10kmc	..	√	..	√	..	
E.M.I. Electronics Ltd. E.M.I.-Cossor Electronics Ltd.	1		..	..	..	..	..	Pulse generator, 50–150 pps.
Electrical and Physical Instrument Corp., 42-19 27th St., Long Island City 1, N.Y.	100, 200, 300, 400		..	..	..	..	..	Pulse generators.
Electro-Pulse, Inc. R-O-R Associates Ltd., 1470 Don Mills Rd., Don Mills, Ont.	Wide range of single and double pulse generators, time delays and gates, digital pulse generators and time mark generators.							
Electronic Instrument Co. Inc. John R. Tilton Ltd., 51 McCormack St., Toronto 9, Ont.	315	75kc-150mc	√	..	√	..	..	All EICO products
	320	150kc-102mc	√	..	√	..	..	are available in kit or
	322	150kc-102mc	√	..	√	..	..	factory wired units.
	324	150kc-435mc	√	..	√	..	..	
	360	500kc-228mc	..	..	..	..	√	
	368	3-216mc	..	..	..	..	√	
Empire Devices Products Corp. Instronics Ltd., Box 100 Stittsville, Ont.	1G-102	10kc-1000mc	..	..	..	..	..	Impulse generator.
	1G-115	10kc-1000mc	..	..	..	..	..	Impulse generator.
	1G-118	100mc-10kmc	..	..	..	..	..	Impulse generator.
General Radio Company, Mass. General Radio Company, 99 Floral Parkway, Toronto 15.	805-C	16kc-50mc	√	..	√	..	√	
	1001-A	5kc-50mc	√	..	√	..	√	
	1021	40mc-920mc	√	..	√	..	√	
	1390-B	20cps-5mc	..	..	..	..	..	Random noise gen.
	1391-B		..	..	..	..	√	Pulse, and time delay
	1392-A		..	..	..	..	..	Time delay gen.
	1217-A		..	..	..	..	..	Pulse generator.
	General Radio Company also manufacturers a wide range of audio, medium and high frequency, vhf, uhf and shf oscillators and accessories.							
Hartmann & Braun AG. The J. W. Ellis Industries, 90 Richmond St. E., Toronto.	6031	100kc-11.2mc	√	√	..	..	..	
	221	50cps-50kc	..	..	..	..	..	Square pulse gen.
	371	4-80, 135-230mc	..	..	..	..	√	TV wobbulator.
Heath Co. Daystrom Ltd., 840 Caledonia Road, Toronto	LG-1	100-290kc	√	..	..	..	..	All Heath products
	RF-1	100-320kc	√	..	..	..	..	are available in kit or
	FMO-1	90, 100, 107mc	√	√	..	..	√	wired units.
Hewlett-Packard Company. Atlas Instrument Corp., 50 Wingold Ave., Toronto 19, Ont.	606A	50kc-65mc	√	..	√	√	..	
	608C, D	10-480mc	√	..	√	√	..	
	612A	450-1230mc	√	..	√	√	..	
	614A	800-2100mc	..	√	√	√	..	
	616A, B	1.8-4.2kmc	..	√	√	√	..	
	620A	7-11kmc	..	√	√	√	..	
	623B	5925-7725mc	..	√	..	..	..	
	624C	8.5-10kmc	..	√	..	√	..	
	626A	10-15.5kmc	..	√	√	√	..	
	628A	15-21kmc	..	√	√	√	..	
	683A, 684B, 686A, 687A	2-18kmc	..	..	..	..	√	Sweep oscillators.
	Hewlett-Packard Co. also manufactures an extensive line of oscillators, pulse generators, square-wave generators, saw tooth generators and delay generators.							
The Hickok Electrical Inst. Co. Stark Electronic Sales Co., Ajax, Ontario.	615	2.5-216mc	..	√	..	..	√	
	695	0-50mc	..	..	..	..	√	
	290X	262kc-20mc	√	..	√	..	..	
	288X	0-50mc	√	√	..	..	..	
	295X	125kc-175mc	√	..	√	..	..	See Stark listing.
ITT Industrial Prods. Div. Standard Telephones & Cables Mfg. Co. (Canada) Ltd., 9600 St. Lawrence Blvd., Montreal	200K	20cps-200kc	..	√	..	..	√	
Jackson Electrical Instrument Co. Canadian Marconi Co., 830 Bayview Ave., Toronto 17.	TVG-2	30kc-216mc	√	..	..	..	√	
Jerrold Electronics Corp. Atlas Instrument Corp. Ltd., 50 Wingold Ave., Toronto 19.	601	12-225mc	..	..	..	..	√	
	602	4-112mc	..	..	..	..	√	
	707	500kc-250mc	..	..	..	..	√	
	900A	500kc-1200mc	..	√	..	..	√	

Manufacturer and Canadian Representative	Model or Type No.	Carrier Frequency	Modulation					Remarks
			am	fm	cw	pulse	sweep	
Kasama Electronics Ltd. Conway Electronic Enterprises Reg'd., 1514 Eglinton Ave. W., Toronto 10.	300 series	1cps-1mc	..	..	..	..	..	Pulse generators.
Kay Electric Company. MEL Sales Ltd., 1969 Avenue Rd., Toronto 12.	Very wide range of sweeping oscillators, oscillators with frequency markers, noise generators, pulse and pulsed carrier generators, miscellaneous instruments.							
Krohn-Hite Corp. MEL Sales Ltd.	Eight oscillators covering the range from 0.001cps to 520kc.							
Lampkin Laboratories, Inc., Bradenton, Florida.	103B, 105B	20-450mc	..	..	√	..	..	
Lavoie Laboratories, Inc. Instronics Ltd., Box 100, Stittsville, Ont.; 21 Benleigh Dr., Scarborough, Ont.	LA-24	15-400mc	√	√	√	..	√	
	LA-48	20-102mc	..	√	√	..	..	
	LA-418B	396-1000mc	√	..	√	√	..	
Lumatron Electronics, Inc. Instronics Ltd.	PG-3	20-250 pps	..	..	..	..	..	Pulse generator.
Marconi Instruments Ltd. Canadian Marconi Co., 2442 Trenton Ave., Montreal 16.	TF 801 series	10-470mc	√	..	√	..	..	
	TF 995A series	1.5-220mc	√	√	√	..	..	
	TF 1066A	10-470mc	..	√	√	..	..	
Measurements, a McGraw-Edison Div. H. Roy Gray Co. Ltd., 44 Danforth Rd., Toronto 13.	65-B	75kc-30mc	√	..	..	..	..	
	80, 80-R	2-475mc	√	..	..	..	..	
	82	20cps-50mc	√	..	..	..	..	
	84-R	300-1000mc	√	..	..	√	..	
	84-TVR	400-1000mc	√	..	..	..	..	
	90	20-250mc	√	..	..	..	..	Plus composite tv mod.
	95	50-400mc	..	√	..	..	..	
	210 series	25-475mc	..	√	..	..	..	
	560-FM	25-960mc	..	√	..	..	..	
	The company also manufactures a range of pulse and square wave generators.							
New London Instrument Co., Inc. Conway Electronic Enterprises Reg'd., 1514 Eglinton Ave. W., Toronto 10.	100D	27-230mc	..	√	..	..	..	
	162	10kc-50mc	√	..	..	..	..	
	183	10cps-1mc	..	..	..	..	..	Square wave gen.
PACO Electronics Co., Inc. Atlas Radio Corp. Ltd., 50 Wingold Ave., Toronto 19.	G-30	160kc-240mc	√	..	..	..	..	Kit or factory-wired.
Philco Corp. of Canada Ltd., Accessory Div., Don Mills Rd., Don Mills, Ontario.	7008C	2.5-250mc	√	√	..	..	√	
	7200	100kc-280mc	√	..	..	..	..	
	7300	2.5-250mc	√	√	..	..	√	
Philips Electronics Industries Ltd., 116 Vanderhoof Ave., Toronto 17.	GM2324	25cps-1mc	..	..	..	..	..	Square wave gen.
	GM2621	4.8-300mc	√	√	√	..	..	
	GM2653/01	32kc-32mc	√	..	..	..	..	
Polarad Electronics Corp. MEL Sales Ltd., 1969 Avenue Rd., Toronto 12.	MSG-1	950-2400mc	..	√	√	√	..	
	MSG-2	2150-4600mc	..	√	√	√	..	
	MSG-34	4.2-11kmc	..	√	√	√	..	
Precision Apparatus Co., Inc. Atlas Radio Corp. Ltd., 50 Wingold Ave., Toronto 19.	E-200C	88kc-440mc	√	..	√	..	..	
	E-400	3-900mc	..	..	..	..	√	Crystal markers.
Radio City Products Co., Inc., Centre at Glendale Sts., Easton, Pa.	TS-418	394mc-1kmc	..	..	..	√	..	AO/USM-49 equiv.
	TS-403	1.8-4kmc	..	√	..	√	..	AN/URM-61A. equiv.
	SG-227	10-15kmc	..	√	..	√	..	AN/USM-47. equiv.
Rank Cintel Ltd. E.M.I.-Cossor Electronics Ltd., 2005 MacKay St., Montreal	3352	0.95cps-1.1mc (0.9usec to 1.05sec period)	..	..	..	..	..	Delayed pulse and sweep generator.
Ribet-Desjardins. Electroline TV Equipment Inc., 5757 Decelles Ave., Montreal 26.	476A	100kc-26mc	..	√	..	..	..	Wobbulator with 'scope.
	410A	0-250mc	..	√	..	..	..	Wobbulator with 'scope.
	411A	0-320mc	..	√	..	..	..	As for 410A.
W. H. Sanders (Electronics) Ltd. Conway Electronic Ent. Reg'd., 1514 Eglinton Ave. W., Toronto 10.	CT312, CT313 and CT314	1.3-12kmc	..	..	..	√	..	
Schomandl K. G. Instronics Ltd., Box 100, Stittsville, Ont.	FD 1	1kc-920mc	..	..	√	..	..	Crystal controlled.
	FD 3	300mc-10kmc	..	..	√	..	..	Crystal controlled.
	ND 5	10cps-31mc	..	..	√	..	..	Prec. freq. decade.

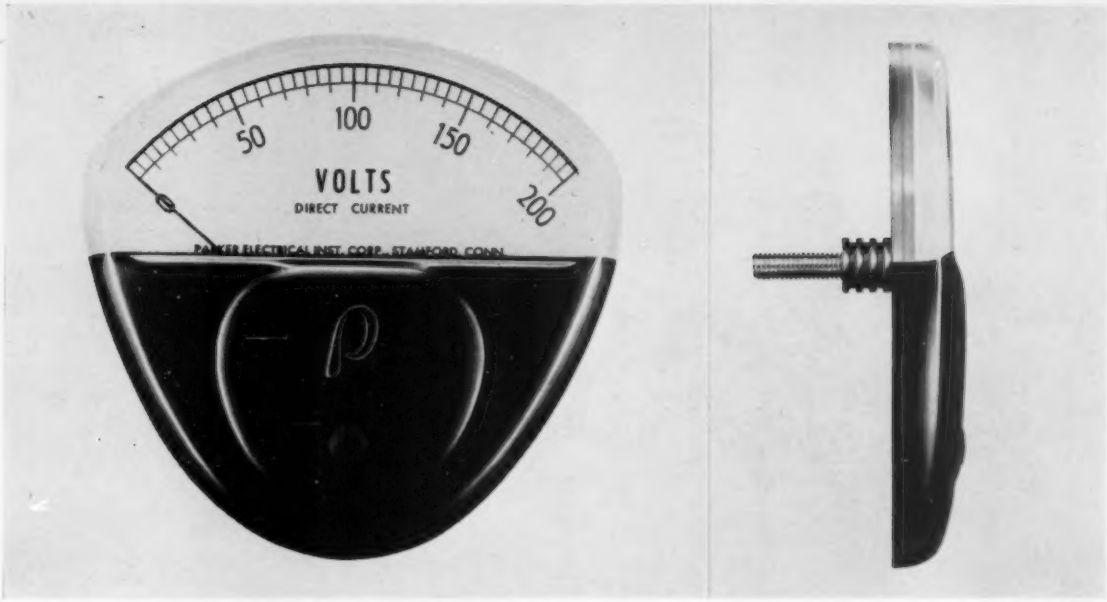
Manufacturer and Canadian Representative	Model or Type No.	Carrier Frequency	Modulation					Remarks
			am	fm	cw	pulse	sweep	
Scientific-Atlanta, Inc. Philips Electronics Ind. Ltd., 116 Vanderhoof Ave., Toronto 17.	SS 301	1-22kmc	..	..	√	..	..	Remote tuned; ext'l. mod.
	SS 305	50mc-2kmc	..	..	√	..	..	Same as SS 301
Servomex Controls Ltd. The Glendon Inst. Co. Ltd., 46 Crockford Blvd., Scarborough, Ont.	LF.51	0.0005-500cps	..	..	√	..	..	Sine, square, pulse, saw-tooth, etc. waveforms at low frequencies.
Sierra Electronic Corp. Atlas Inst. Corp. Ltd., 50 Wingold Ave., Toronto 19.	201B	1.3-2.5mc	√	..	..	..	..	Also ext'l. fm.
Southwestern Ind. Electronics Co. Radionics Ltd., 8230 Mayrand St., Montreal 9.	N-1	2cps-200kc	..	..	√	..	..	Battery portable
Spencer-Kennedy Labs., Inc. E.M.I.-Cossor Electronics Ltd.	503	50-150pps	..	..	..	..	..	Pulse generator; 1 musec risetime.
Sperry Gyroscope Co. of Canada Ltd., P.O. Box 710, Montreal.	570	8.5-10.5kmc	..	√	√	√	..	AN/UPM-32 equiv.
	590	2.7-3.55kmc	..	√	√	√	..	AN/UPM-44C equiv.
Stark Electronic Instruments Ltd. Stark Electronic Sales Co., Ajax, Ontario.	295X	125kc-175mc	√	..	√	..	..	See also Hickok.
	LSG-10	120kc-260mc	√	..	√	..	..	
	MHG-48	3.5-250mc	√	..	√	..	..	
	RFG-2	110kc-130mc	√	..	√	..	..	Kit and wired.
	SMG-57	3-260mc	..	..	..	..	√	
	SWG-58	140-260mc	..	..	..	..	√	
Taylor Electrical Instruments Ltd. Conway Electronic Enterprises Reg'd., 1514 Eglinton Ave. W., Toronto 10.	68A	100kc-240mc	√	..	√	..	..	
	92A	5-250mc	..	√	..	..	√	
	94A, B	4-220mc	√	√	√	√	√	
Tektronix, Inc., 3 Finch Ave. E., Willowdale, Ont.	105	25cps-1mc	..	..	..	..	..	Square wave gen.
	107	400kc-1mc	..	..	..	..	..	Square wave gen.
	110	720pps	..	..	..	..	..	Pulse generator.
	160 series	Modules provide a flexible system of sequence control with timed, adjustable pulses.						
	180A and 181		..	..	..	..	..	Time mark generators.
Telerad Mfg. Corp. Instronics Ltd.	TSG-147D	8500-9600mc	..	√	√	..	√	
Teletronics Laboratory, Inc. Computing Devices of Canada Ltd., Box 508, Ottawa.	PG series	5-5000 usec intervals			..	..	..	Pulse generators.
	TP-100	20cps-100kc	..	..	√	..	..	Push button oscillator.
Tel-Instrument Electronics Corp. Atlas Instrument Corp. Ltd., 50 Wingold Ave., Toronto 19.	1105	50kc-10mc	..	..	..	..	√	Video sweep gen.
	1211	450-900mc	..	..	..	..	√	Wobbulator.
	1212	Channels 2-13	..	..	..	..	√	Wobbulator.
	1500B	400kc-70mc	..	..	..	..	√	Wobbulator.
	1900A	4-60mc	√	..	..	..	..	Push button selector.
	1902A	4.5mc (fixed)	√	√	√	..	√	
Telonic Industries, Inc. Box 87, Beech Grove, Ind.	HD-1A	1-900mc	..	..	..	..	√	
Trad Electronics Corp. MEL Sales Ltd., 1969 Avenue Rd., Toronto 12.	RT-500	190kc-400mc	√	..	..	..	..	AN/TRM-1 equiv.
	SG-25	10kc-50mc	√	..	√	..	..	AN/URM-25D equiv.
	SG-26	4-405mc	√	..	√	..	..	AN/URM-26B equiv.
	TD-1101	6-410mc	√	..	√	..	..	Plus external pulse mod.
The Triplett Electrical Inst. Co. Len Finkler and Co., 1794 Avenue Rd., Toronto 12; C. M. Robinson Co., 1550 Erin St., Winnipeg 3.	3432-A	160kc-110mc	√	..	√	..	..	
	3434-A	0-240mc	..	..	..	..	√	
Waltham Electronics Corp. Conway Electronic Enterprises Reg'd., 1514 Eglinton Ave. W., Toronto 10.	100T	200-550mc	..	√	√	..	..	
	115	360cps-100kc	√	√	√	..	..	
	116	400cps-70kc	√	√	√	..	..	Pre-set frequencies.
	237	380-430mc	√	..	..	..	..	Ultra-stable gen.
	238	2160-2400mc	..	..	√	√	..	Ultra-stable gen.
Wandel & Goltermann. R-O-R- Associates Ltd., 1470 Don Mills Rd., Don Mills, Ontario.	LMS-68 series	4-960mc	√	..	√	..	..	Plug-in units.
	Wandel & Goltermann also manufacture a wide range of low, medium, and high frequency oscillators.							
Wayne Kerr Corp. The Glendon Instrument Co. Ltd., 46 Crockford Blvd., Scarborough, Ont.	P131	50-50000pps	..	..	..	..	..	Pulse generator.
	S-121	10cps-120kc	..	..	√	..	..	
	S-281	2.7-4.0kmc	..	..	..	√	..	Square wave mod.

Cathode ray oscilloscopes — continued

Manufacturer	Model or Type No.	Frequency Response	Sensitivity	Accel. Pot'l.	Remarks
Allen B. DuMont Labs., Inc.*	425 Dual trace	dc-35mc (usable to 60mc)	50mv/cm	12kv	Plug-in units; digital readout feature.
EMI Electronics Ltd. E.M.I.-Cossor Electronics Ltd.*	WM8	dc-15mc	50mv/cm	6kv	Also ac coupling.
	WM16 Dual trace	dc-40mc	50mv/cm	ina	Plug-in units; also ac coupling.
Hartmann & Braun AG (Grundig)*	705a	20cps-10mc	28mv/cm	ina	Post-accel. available.
Hewlett-Packard Co.*	150A Dual trace	dc-10mc	5mv/cm	5kv	Plug-in units.
	160A Dual trace	dc-14mc	20mv/cm	5kv	Plug-in units; also ac coupling.
Lavoie Laboratories, Inc. Instronics Ltd.*	LA-270 Dual trace	dc-50mc	50mv/cm	ina	Plug-in units.
Marconi Instruments Ltd.*	TF 1227	dc-10mc	ina	ina	For TV testing.
	TF 1330	dc-15mc	50mv/cm	10kv	Also ac coupling.
	TF 1331	As for TF 1330			Dual trace.
Philips Electronics Ind. Ltd.*	GM 5602	3cps-14mc	75mv/cm	4kv	
Ribet-Desjardins.*	204A	dc-50mc	50mv/cm	2kv or 4kv	Synchroscope; double scanning.
	251A Dual trace	dc30mc	50mv/cm	2kv	Synchroscope; double scanning.
	252C	dc-10mc (—5db)	50mv/cm	4kv	
	254A Dual trace	dc-10mc (—6db)	20mv/cm	4kv	Change amp. for dual trace.
Tektronix, Inc.*	316	dc-10mc	100mv/div.	1.8kv	10mv/div. with ac preamp.
316, 317, 515A, 524AD do not have plug-in units; 317 is daylight-viewing instrument.	317	dc-10mc	100mv/div.	9kv	10mv/div. with ac preamp.
	515A	dc-15mc	50mv/cm	4kv	
531A, 533, 535A, 536, 541A, 543, X544, 545A, 551, 555 use plug-in units. Passband is max. using Type K or L units. Sensitivity is max. using new X53/54F unit. Rack-mounting versions available.	524AD	dc-10mc	150mv/cm	4kv	15mv/cm with ac preamp.
	531A, 533 and 535A	dc-15mc	10uv/cm	10kv	
	536	dc-11mc†	10uv/cm	4kv	X-Y plotting.
	541A, 543, X544, 545A, 555	dc-30mc	10uv/cm	10kv	X544 has illuminated digital readout; 555 is double beam unit.
Waterman Products Co., Inc.*	S-4-C	1.5 cps-11mc	280mv/in	2kv	Equivalent to AN/USM-25.

Group 4. Special oscilloscopes using pulse-sampling, etc.

Edgerton, Germeshausen & Grier, Inc. Samuel C. Hooker (Canada) Ltd., 2425 Grand Blvd., Montreal; 256 Cornelius Pkwy., Downsview, Ont.	2236A MILLI-MIKE	Greater than 3000mc; pulse risetimes of 0.1 musec can be reproduced.	54mv/trace width, i.e. per 0.002". (27v/in)	3kv	Traveling wave type deflection; post-accel. to 20kv. Type 710 camera available.
Hewlett-Packard Co.*	185A Dual trace	Greater than 500mc; pulse risetimes of less than 0.7 musec.	3mv/cm	ina	Uses 187A dual-trace pulse-sampling plug-in. X-Y recorder output.
Lumatron Electronics, Inc. Instronics Ltd.*	112	Pulse risetimes of 0.4 musec.	5mv/cm	ina	Pulse-sampling; mods. include built-in pulse generator, camera controls, X-Y recorder output, digital output, etc.
Separate pulse-sampling and trigger units available for use with conventional oscilloscopes.					
Tektronix, Inc.*	517A	Pulse risetimes of 7 musec.	50mv/cm	24kv	Helical post-accel. anode
Separate pulse-sampling plug-in Type N available for use with 530, 540 and 550 Series 'scopes, for risetimes of 0.6 musec. Also Type 110 pulse generator and trigger takeoff; Type 113 delay line.	519	dc-1kmc; pulse risetimes of 0.4 musec.	10v/cm	24kv	Traveling wave type deflection; pulse generator included.
	581	dc-100mc; 0.35 musec risetime.	100mv/cm	10kv	Traveling wave type deflection; type 80 plug-in.
	585	As for 581, but includes variable sweep-delay generator.			



105

New components

Panel meter uses printed coil movement 105

The Parker surface mounting panel meter uses a printed circuit coil in conjunction with a thin ceramic ring magnet. The entire meter is contained in the scale housing and nothing projects from the rear except the terminals which also serve as mounting screws. Its heart is a featherweight disc on which are printed four coils. This, together with a nylon pointer and thin ring magnet assembly makes up the complete movement.

Series S35 3½ in. meters are available with full scale ratings of 1, 2, 5, 10, 20, 50, 100, 200, 500 ma; 1 ampere; 10, 50, 100, 200, 500 volts.

Interlab Inc., New York.

Junction terminal bushing 106

Heyco's junction terminal bushing is a miniature nylon insulated receptacle for use with standard female wire terminations. They provide insulated quick disconnect access through housings and feature snap-in installation. It can also be used as a jack or plug-in receptacle.

Cords (Canada) Ltd., Toronto.

Hysteresis clutches and brakes 107

Manufactured under license in Canada, these magnetic clutches and brakes have a torque proportional to excitation and the drive may be synchronous without slip. Eddy current effect is insignificant so that torque or braking force is independent of slip speed. Industrial units are furnished in configurations from 1/500 hp to 5 hp at 1750 rpm.

Found Bros. Aviation Ltd., Malton, Ont.

Beam power tetrodes 108

Three beam power tetrodes types 6146, 6159 and 6883 have been developed for use as rf amplifiers, oscillators and frequency multipliers and as af amplifiers and modulators in mobile and fixed communications equipment.

All three types are identical with the exception of their filament voltages. These are 3.3v for type 6146; 26.5v for type 6159; 12.6v for type 6883. Types 6146 and 6159 have a large wafer octal 8-pin base (Jetec B8-86) and the 6883 has a small wafer 8-pin base (Jetec B8-159).

Rogers Electronic Tubes and Components, Toronto.

Tunnel diode 109

Sample quantities of diode type ZJ-56A, a 1000 mc device are available at $69.00 each. These are hand made samples for design use.

Features of the new tunnel diode include a minimum peak-to-valley current ratio of 5 to 1, a typical peak point current rating of 1 ma which is held to ±10%, and a typical negative conductance of 0.065 mho. Typical peak point voltage is 55 millivolts and typical valley point voltage is 350 millivolts.

Canadian General Electric Co. Ltd., Toronto.

Crimp type cable connectors 110

A new series of crimp type BNC connectors designated the 31 series feature: quick assembly (only 3 basic parts plus rubber boot to assemble and crimp), increased realiability (cable retension and strain release improved by crimping), elimination of critical assembly operations and weatherproofing.

Series 31 connectors are available for use with several RG cables in a variety of plugs and jacks, right angle plugs, bulkhead jacks, and cable terminations.

Amphenol Canada Ltd., Toronto.

Miniature power dividers 111

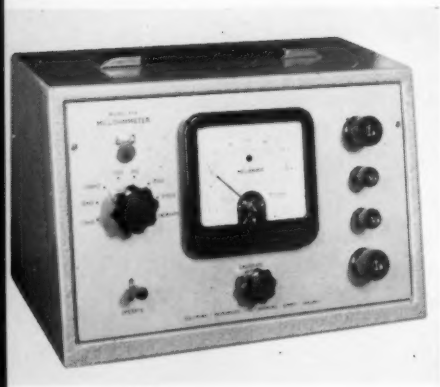
A complete line of miniature, lightweight power dividers for airborne application has been introduced by Transco Products Inc. Design features include broad bandwidth and low vswr Impedance is 50 ohms and vswr is less than 1.3 to 1. They are available for 2 or 3-way power division in the L, C, S, and X bands.

Delta Aircraft Equipment Co., Toronto.

(Continued on page 62)

112

New instruments



114

113

For further information on New Product items, use the Reader Service cards on pages 81 and 82

Sweep and marker generators 112

Model SWG-58 sweep generator has been designed for alignment of tv, fm and vhf receivers. Frequency range is 3 mc to 260 mc in 2 bands; sweep deviation is 0 to 12 mc; sweep method is vibrating capacitor, sinusoidal; amplitude variation is less than 3 db at 12 mc deviation; output impedance is 75 ohms, unbalanced; output voltage is 1,000 microvolts, variable.

Model MHG-48 marker generator has been designed for use in the alignment and servicing of receivers or tv, fm and vhf. Frequency range is 3.5 mc to 250 mc covered in six bands. Frequency calibration is within 1%. The quartz crystal operates at 4.5 mc, ±0.002%. Output voltage is 1000 microvolts variable and output impedance is 75 ohms unbalanced.

Stark Electronic Sales Co., Ajax, Ont.

Portable secondary time standard 113

Secondary time standard is a self-powered timing device that can be used for on-off control of recording instruments, telemetering transmitters, etc., located in remote or isolated areas, at precise intervals. The unit's transistorized radio receives time signals broadcast by the U. S. Bureau of Standards time station, WWV and feeds them to a decoder in its circuitry that keeps the instrument's clock synchronized with them to maintain an accurate time reading. As a control unit, the instrument can turn on the switch of any electrical device at 15, 30, 45 or 60 second intervals, and also at 5, 10, 15, etc., minutes up to and including 1 hour, or any multiple of five minutes. The three-band radio is powered by two 6-volt standard batteries and a standard 1½ volt battery. It will operate for several months before a fresh set of batteries is required. The Hamilton clock operates up to a year on its own separate 1½ volt battery.

Zenith Radio Corp., Chicago.

Transportable milliohmeter 114

Electronic Instruments Ltd., milliohmmeter model 47A has been designed for the measurement of low and very low resistance from 1200 ohms down to 50 microhms. It is a transportable, direct reading instrument with the following features: simple operation, wide range, absence of batteries and minimal heat dissipation in test circuit. The resistance coverage is from 1.2 milliohms full scale deflection to 1,200 ohms in 7 ranges. The test current is 10 amperes ac on the lowest range, falling to 10 microamps on the highest. The test voltage is up to 12 millivolts for any range varying with test resistance; the open circuit voltage is 1.25 volts. Accuracy is generally better than ±2% of full scale deflection.

The Glendon Instrument Co. Ltd., Scarborough, Ont.

(Continued on page 66)

New equipment

Flight simulation table 115

Model 17A two-axis flight simulation table can handle a 25-lb. load. The natural frequency of each axis is in excess of 15 cps. Adjustable damping is provided and the threshhold of each axis is less than 0.005 deg. The table will follow signals such as those from an analog computer, a low frequency function generator, tape recorder, or digital-to-analog converter.

Micro Gee Products, Inc., Culver City, Calif.

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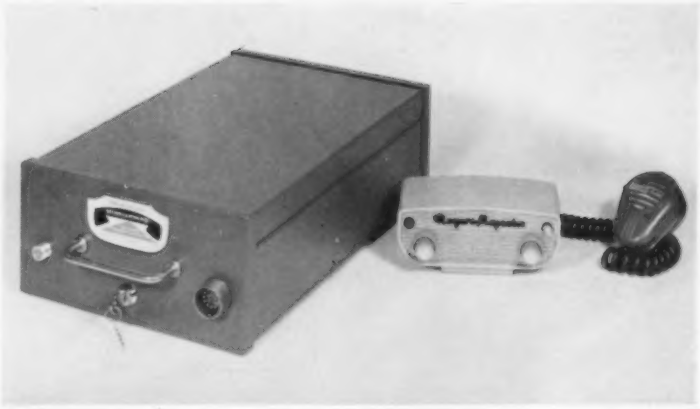
Mobile radio 116

Rogers Majestic Mobilophone has a transistor power supply, full 30-watts output and measures 5½ in. high, 10⅜ in. wide, 18-in. long. The frequency, 148 to 174 mc can be used with standard 60 kc channel spacing or 30 kc split channel in up to two channel operation. Other features are transistorized microphone; sealed Ferroxcube i-f filter for lifetime selectivity and performance; individual heat sinks for power transistors and automatic deviation control.

Philips Electronics Industries Ltd., Toronto.



116

Single sideband transceiver 117

Transceiver model 32RS-1 can provide up to 4 crystal-controlled frequencies in the 1.6 to 15 mc range, selected by a switch. In transmission it provides 100 watts peak envelope power output. A balanced modulator and mechanical filter sideband generator, multiple tuned circuits and linear amplifier assure a clean signal in transmission. The equipment is suitable for use in mixed am/ssb systems since compatible am operation (reinserted carrier) is available and controlled by a switch. The transmitter is actuated by a voice relay making it possible to operate the transceiver through telephone extensions or switchboards without additional equipment.

Collins Radio Co. of Canada Ltd., Toronto.

Three phase power supply 118

Elin model MK-150 three-phase 50 va power supply employes voltage and current sensing on each leg to obtain a high degree of regulation. Delta and Wye connections are located at the rear panel of the unit for easy accessibility. Input requirements are 225 w, 105-125 v, single phase. Output voltage is regulated ± 1%; frequency is regulated ± 1% on standard models or 0.001% on special order; line to line regulation is 0.1%; output distortion is 0.2%; load power factor is 1.0 to 0.3 per customer specification.

R-O-R Associates Ltd., Don Mills, Ont.

Regulated power supply 119

Kepco voltage regulated dc power supply has regulation of 0.1% for line and load (0.01% regulation provided on special order). Output range is variable from 0 to 325 vdc at 200 ma (model HB-2), 400 ma (HB-4) or 600 ma (HB-6). Ripple is 3 millivolts rms.

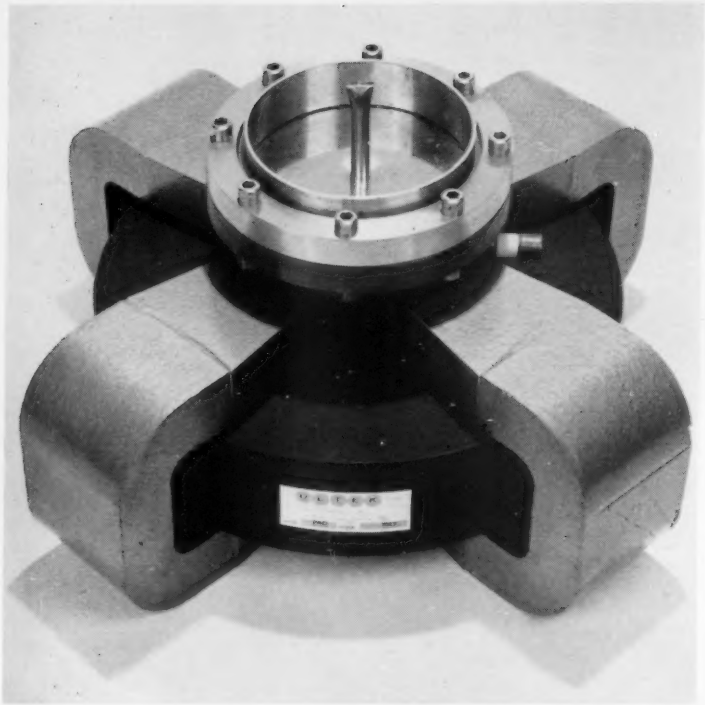
Ward Leonard of Canada Ltd., Toronto.

Transistorized amplifier 120

Model AR 108 is a direct coupled differential amplifier using silicon transistors throughout. While its main application lies in the amplification of small signals for recording on magnetic tape, it is also suitable for general use in telemetering and ground use. Over the temperature range of 0 to +130F, zero drift is less than 1/10 millivolt referred to the input. At maximum sensitivity, an input of 5 millivolts will provide a constant current output of ½ ma to a load of 0 to 5,000 ohms. When operated into a load of 100,000 ohms, the maximum output of 5 volts is available. The differential input impedance of the amplifier is 5,000 ohms and the frequency response is flat from dc to 5 kc.

Leach Corp., Compton, Calif.

(Continued on page 72)



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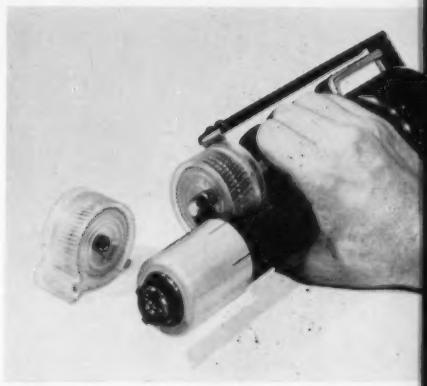
122



123

Other new products

High vacuum electronic pump 121

Series 240 UlteVac high vacuum pump is a general purpose unit with a 40-liter per second capacity. Operating on a cold-cathode discharge within a magnetic field, it has no moving parts and the modular internal structure is easily removed for maintenance or replacement. A roughing vacuum of 15 to 20 microns is required only for starting. After this the system can be sealed off and the series 240 will produce a clean, ultimate vacuum below 1 x 10^{-9} mm Hg.

Ultek Corp., Palo Alto, Calif.

Hubloc parabolic antennas 122

These antennas utilize a simple structural connection. The reflector backup frame employs two basic elements. These are tubular, bar or strap type structural elements and connecting hubs. The hubs have a number of formed keyways and the structural member ends are embossed with a corresponding pattern which provides a press fit in the hub keyway. The resultant connection has a structural efficiency in excess of 90% in tension as compared to the usual efficiency of 75% or less for bolted or riveted connections, and 65% or less for welded aluminum connections. The antennas are available in a range of sizes up to 60 ft. in diameter.

Andrew Antenna Corp., Whitby, Ont.

Pneumatic crimping tool 123

This pneumatic crimping tool for either hand or bench operation handles both pins and sockets used in the Deutsch DS series miniatures. Contacts are provided in disposable plastic cartridges which simply snap in or out of the crimping tool. It will crimp with a strength exceeding that of the wire in sizes AN #18 or smaller. In case of air failure or intermittent pressure, the tool will stop, thus ensuring positive crimp each time.

Brian Engineering Ltd., Montreal.

Low shrink silicone rubber 124

Two new types of low shrink silicone rubber stock have been introduced for cable and wire insulation. Type K-1347 is a premium grade material designed for use on wire to meet military and industry specifications. It can be continuously vulcanized at the wire factory on conventional equipment, with either steam or hot air. It is supplied in sheet form in 25 and 50 lb. cartons.

Type K-1357 is available in coiled strips for direct feed to the extruder. It can be cured in either steam or hot air. Both compounds are white in color, and can easily be color-coded.

Bakelite Co., Toronto.

Prototype punching machine 125

Strippit Fabricator model 15A is designed for punching, notching and nibbling, particularly for prototype work, short or medium production runs. It features an electro-hydramatic head which is the part of the machine controlling the power stroke of the ram. This eliminates the need for pressurized air required on earlier models of the machine. A relatively simple electrically controlled solenoid valve replaces the air motor, air motor valve, linkage and piping formerly required.

Strippit Tool & Machine Co., Brampton, Ont.

(Continued on page 74)

Investigations are not likely to change Canada's nuclear program

by D. Peacock, Ottawa Editor

It seems unlikely that the Commons committee investigation of Canada's atomic energy development program and uranium-marketing policies will produce any radical changes in the present status quo.

What is more likely, government atomic experts are confident, is that the airing of these problems will only serve to show that the present course is as good as any that could be followed at this time.

Trade Minister Churchill has provided for a select 20-member committee to study operations of Atomic Energy of Canada Limited, Eldorado Mining and Refining Limited and the National Research Council. Committees conducted similar investigations in 1956 and during the 1952-53 session.

Undoubtedly there will be plenty of fireworks during the committee's hearings. Lately, there has been very vocal criticism of the system of atomic power generation being developed by AEC. These critics will be given a chance to air their views fully before the committee.

These non-government atomic experts are critical of the government's decision to build atomic power plants using natural uranium as a fuel and heavy-water as the control and heat-transfer agent. They argue that systems using expensive enriched uranium and graphite or gas instead of heavy water, are more promising.

They also argue that Canada should be building plants for the manufacture of enriched uranium, believing this will be a more valuable export than natural uranium.

Britain is developing graphite and gas reactors. All types are being explored in the United States, which has the financial resources for such large-scale experimental development.

One of the aces Canadian government experts feel they have up their sleeves is the fact that so far, no one anywhere has proved which system is superior.

Experts at AEC are said to be more convinced than ever that the heavy water-natural uranium approach offers the brightest chance of building the kind of big power stations capable of turning out economic electricity that Canada needs most.

They apparently are confident the committee will find evidence that such power stations will prove the best for feeding large quantities of power into existing grids. This aspect is considered especially important for Ontario, which has already put into use most of its available hydro resources.

They also point out that the government is experimenting with other types of atomic power plants suitable for small stations in the north or as a separate unit for a small community or an industrial plant.

In view of Canada's limited financial resources in this field, they—and very likely Mr. Churchill himself—are confident that the chief result of the committee will be to silence the outside critics.

1960 nuclear congress

R. A. Frigon (l), Dept. of Trade and Commerce is in charge of Canadian display at the Atomic Exposition. With him are E. Leaver, Electronic Associates Ltd., and C. Kennedy, Atomic Energy of Canada Limited.

Canada will have a strong representation at the 1960 nuclear congress in New York, April 4-7. The Department of Trade and Commerce has leased an entire island of exhibit space at the exposition, and is co-ordinating the displays from 14 Canadian companies who will be there.

This work has been under the direction of Mr. R. A. Frigon, chief of the engineering and equipment division, Foreign Trade Service. Emphasis will be on Canadian designed and produced nuclear equipment available for export.

A streamlined program, covering seven major areas of interest in the atomic field, has been planned for the Nuclear Congress. All 57 technical papers will concentrate on nuclear production problems.

Co-ordinated with the Congress program will be sessions of the eighth Atomic Energy in Industry Conference, and sessions of the Society of Automotive Engineers on nuclear propulsion in aircraft.

Proton synchrotron in operation

The proton synchrotron built by the European Organization for Nuclear Research (CERN) has gone into operation. Designed for an output of 25 BeV, the machine is reported to have achieved an energy of 24 BeV during early trials.

Radioisotope altimeter

A new type of altimeter, designed for increased accuracy at high cruise altitudes, has been developed by Boeing Airplane Company for use in high-performance missiles and jet aircraft. Called a radioisotope density altimeter, the device measures radioactive back-scatter, proportional to atmospheric density.

Wind tunnel and laboratory tests indicate a capability of providing dial altitude readings accurate to within an estimated 500 feet or less at altitudes above 25,000 feet. A proposal for flight testing has been made to the United States Air Force Flight Control Section, Wright Air Development Center. The new altimeter is not intended to supplant conventional pressure-type altimeters at lower altitudes and within terminal areas.

The new device consists of four major units: Probe, radioactive source, detector and electronic circuits.

The probe, a precision-machined aluminum or melamine tube about 30 inches long, is mounted on the outside of the airplane, usually at a wing tip. The radioactive source is secured in a rectangular frame mounted in a sampling window in the side of the probe. Atmospheric back-scatter from the source, a beta-emitting radioisotope with long half-life, is detected by a stilbene-impregnated plastic scintillator, then sensed by a photomultiplier tube, amplified and counted on a scaler.

CORRECTION

The caption for the photograph on page 41 of the January issue of CEE inadvertently referred to Sir John Crockford. It should have read Sir John Cockcroft, part-time member UKAEA and master of Churchill College, Cambridge.

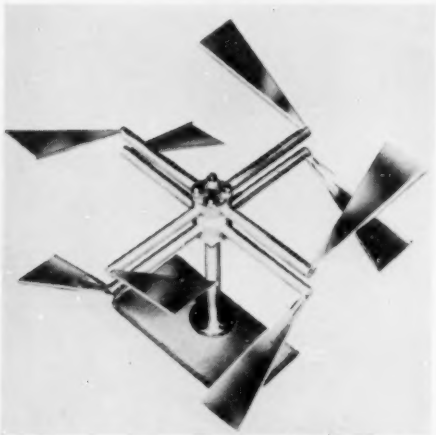
Two Sperry Gyroscope Company scientists conduct exacting studies of the behavior of infra-red radiation in atmospheres vastly different from that of earth. Special 86-foot-long tunnel has blackened walls to control background radiation.

What's new in view

Research in physics paves way for new electronic products

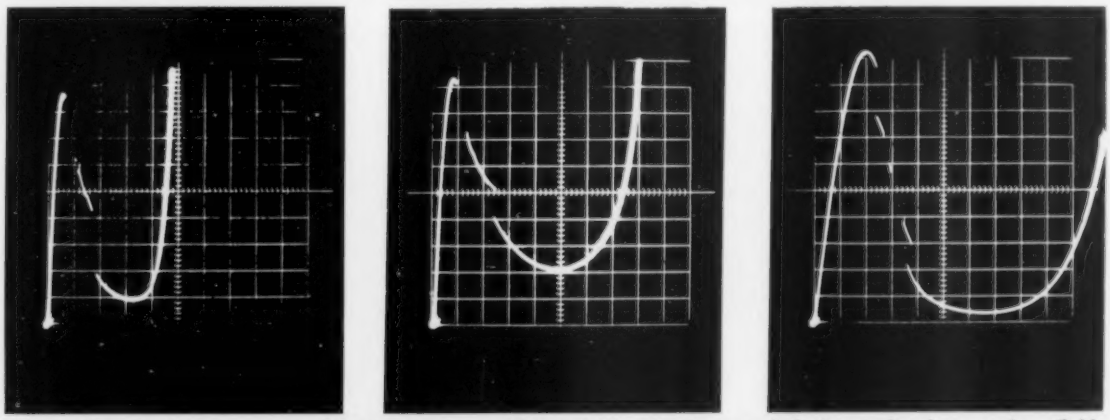
R. J. Kirkpatrick, a Bell Telephone Laboratories scientist, checks three-stage, wide-band amplifier developed for use up to 750 mc with 18 db gain. It uses new miniature germanium pnp mesa transistor, also developed at Bell Telephone Laboratories.

Paul P. Webb holds sample of new semiconductor alpha-particle detector developed at RCA Victor Co. research laboratories in Montreal.



Dynatronics, Inc. omni-directional telemetry antenna has pattern similar to quarter wave stub, except that it is circularly polarized.

This free-space room in antenna and radar laboratory, Wichita Division of Boeing Airplane Company, approximates outdoor environment with r-f absorbing material on three walls, ceiling and floor.

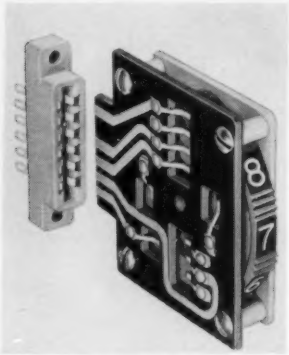


This oscilloscope E-I curve trace shows comparison of General Electric Co. tunnel diodes made of germanium (left), silicon (centre) and gallium arsenide. The new gallium arsenide tunnel diodes work at frequencies above 4,000 mc.

New components—cont.

Binary thumbwheel switch 126

Series TSB modular 10-position binary thumbwheel switches require only ½ in. panel space and only one number at a time is visible through the bezel window. The switches are available with wafers replaceable in 10 seconds for quick servicing and lower maintenance cost, or with fixed wafers if removable feature is not needed. Removable type switch plugs into fixed printed



circuit receptacle and fixed type switch is designed with soldering terminals. Three or four bit binary and complementary outputs can be furnished. Modular construction permits horizontal or vertical stacking.

Chicago Dynamic Industries, Inc., Chicago.

Phase sequence relays 127

These relays offer automatic monitoring of three-phase power and if the incorrect phase sequence is applied, the unit prevents current from passing through to equipment which could be damaged. The unit senses the phase sequence and operates to close a contact when the applied phase sequence is correct. For any other sequence, or if any lead or combination of leads are open and/or grounded, the relay will not operate. Six voltage and frequency ranges are available.

Master Specialties Co., Los Angeles.

Tunnel diode 128

General Transistor Corp. has a pilot production line in operation for engineering samples of tunnel diodes. Germanium is the semiconductor material now being used by GT, but others will be used later on. The tunnel diode is also being developed in a package suitable for integration into a microwave circuit.

Desser E-E Ltd., Montreal. Scarborough, Ont.

Microminiaturized toroidal inductors 129

Burnell and Co. Inc. Model MT 34 microminiature kernel is recommended for frequencies to 30 kc and can be supplied with inductances up to 500 millihenrys. With inductances up to 200 millihenrys, MT 35 kernels are applicable to frequencies ranging to 200 kc. Q for the MT 34 is greater than 55 at 25 kc and for the MT 35 more than 60 at 100 kc.

M. J. Howard & Co. Ltd., Ottawa.

Subminiature connectors 130

A new series of subminiature connectors introduced by U. S. Components, Inc., features a stainless steel reinforcing retainer under each screwlocking element to remove all torque stresses from the molded bodies. Positive re-entrancy of the male pins is assured each time by a flanged guide female contact. Self-alignment action is also assisted by provision of wider countersink on upper end of contact. The connectors are available in total contacts of 7, 11, 14, 20, 26, 32 or custom configurations.

J. J. MacQuarrie Sales, Toronto.

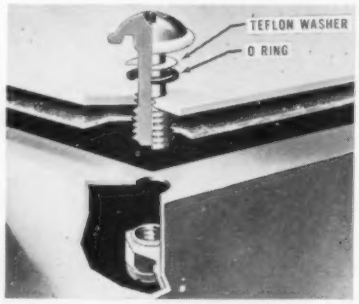
Time delay relay 131

Series STR relay will reset the instant it is de-energized, providing the same time delay period for each succeeding cycle. This has been achieved by employing a thermal element in conjunction with a pair of magnetic relays. This utilizes the heating and cooling intervals to obtain the total time delay period. Voltage compensation is provided for operation on 22 to 32 vdc. Temperature compensation is over the range of —65 C to +125 C. Power drain is less than 3 watts after the timing period and 10 watts during timing. Contact rating is 2 amperes at 28 vdc resistive load.

Canadian Curtiss-Wright Ltd., Montreal.

Self-sealing screws 132

These pressure tight, captive self-sealing screws have been designed for unlimited reusability on pressurized covers, panels and cases. Properly nestled in a groove in the head of the screws are any of a choice of the number of Mil Spec O-Rings, lubricated by a thin Teflon



washer to prevent inadvertent galling or cutting. Special metals, sealants, configurations, and drives are available on request.

Aero Bolt & Screw Co. Inc., Inglewood, Calif.

(Continued on page 64)

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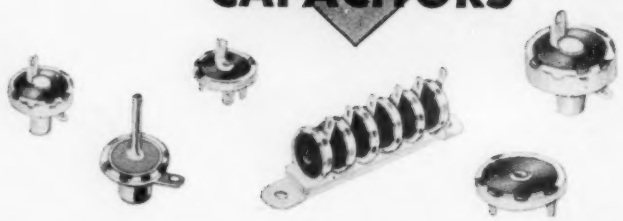

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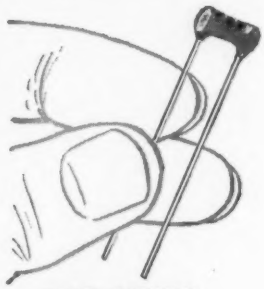

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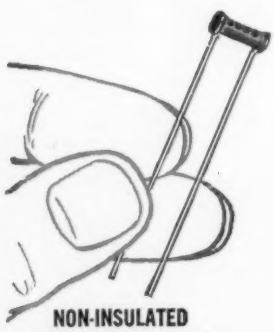
These Radial lead units are dipped in low-loss phenolic material which is baked and vacuum wax impregnated.



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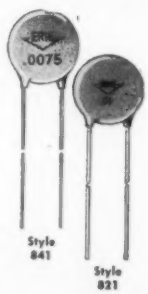

GENERAL PURPOSE Disc Ceramicons have low series inductance which assures efficient high frequency operation. Values from 1 mmf to .05 mfd. Rated at 500 Volts D.C. Working.

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New components—cont.

Semi-air space coaxial cables 133

Coaxial cables of semi-air space design, with low-loss, wide band capabilities have been developed for use at 300 deg. C and 500 deg. C. by Phelps Dodge Copper Products Corp. Spirafil is a coaxial cable where the copper inner conductor is supported within the outer conductor by a helically applied filament dielectric. Filled Teflon is the dielectric used at 300 deg. C, while a dielectric of Refrasil or quartz is used in the 500 deg. C cable. The company has also developed a laminate metallic tube construction for the outer conductor.

Both new cables can be supplied in lengths up to 100 ft. or more. They are available with either a smooth or corrugated outer conductor. A sealed cable system is assured when the proper cable fittings are used, and these fittings are available from the company.

Dayrand Ltd., Montreal.

Variable attenuators 134

A line of low-cost, direct-reading variable attenuators has been introduced by the Narda Microwave Corp. New design principle utilizing a variable inserted Narda-Iron cam provides minimum frequency sensitivity and low vswr over the entire frequency and attenuation range. The direct reading dial is calibrated to within 1 db up to 10 db and 1.5 db up to 20 db over the entire waveguide frequency range. Maximum

attenuation exceeds 25 db and minimum insertion loss is under 0.5 db. Models are available for K, V, Q, M and E bands.

MEL Sales Ltd., Toronto.

Test equipment isolators 135

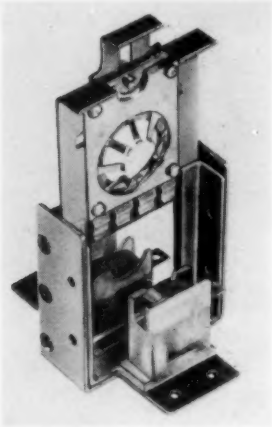
This series of test ferrite isolators is available in eight waveguide sizes from WR-28 to WR-284. They permit optimum frequency stability of the test equipment source during test measurements and extend the life of the rf source by providing a high degree of isolation between the source and the component under test.

Airtron Canada Ltd., Toronto.

Miniaturized tube socket 136

Instruments for Industry, Inc., has designed a tube socket for the General Electric GL6299 uhf planar triode that enables the designer to realize practical uhf lumped constant circuitry with assurance of bandpass stability as tubes are changed.

Designated XV-100/6299, the rugged socket permits tube removal and replacement with absolute seating every time. The miniaturized tube socket can be used to 1000 mc or higher with no resonances over the band. The ground plane



provides isolation between input and output for amplifier stability. The socket has met and exceeded a number of environmental tests.

Electrodesign, Montreal.

Tungsten strand coils 137

Three new tungsten strand coils for vacuum metallizing, two of them with aluminum cores, have been introduced by Sylvania Electric Products, Inc., the sizes of the aluminum core coils are 3 x 0.025 in. and 3 x 0.030 in. The other new coil is 4 x 0.030 in. Controls in the processing of tungsten assure a uniform wire with a controlled recrystallization rate to produce a uniform flash-over in the vacuum metallizing process.

Sylvania Electric (Canada) Ltd., Montreal.

Relay switches microvolts 138

Micro-Scan relays have been designed for dc asynchronous and synchronous switching of extremely low microvolt level to moderate level signal circuits such as found in digital, analogue and measurement applications. Centre pivoted design permits application in environments formerly impossible for mechanical relays. They are available in dpdt and spdt models with a contact rating of 0-10 volts at 1 ma. Operating time is less than 750 usec and the driving system requires less than 500 milliwatts to the polarized centre-tapped coil. Thermal noise is less than 3 microvolts and contacts are arranged to make-before-break or break-before-make with centre position off.

James Electronics, Inc., Chicago.

Miniature fasteners 139

Miniature Southco Division Lion quarter-turn fasteners have been designed to provide smaller dimensions to save weight and space. The receptacle measures only 0.812 inch by 0.375 inch overall and has a thickness of 0.012 inch. The retainer and stud are correspondingly proportioned. Six different stud lengths accommodate total material thickness (both sheets) of 0.040 inch minimum to 0.159 inch maximum. The three parts are made of cadmium-plated steel. They require only one-quarter turn to open and close.

A. T. R. Armstrong Co., Toronto; Black Bros. Ltd., Vancouver.

Magnetic shield 140

A new Netic Co-Netic magnetic shield has been developed for use with Hughes type H-1010AP20 Tonotron storage tubes and similar electron beam display tubes. Because the shield is non-shock sensitive, non-retentive and does not require periodic annealing, tubes may be permanently potted and located close to other electronic equipment.

Magnetic-Shield Division, Perfection Mica Co., Chicago.

(Continued on page 66)

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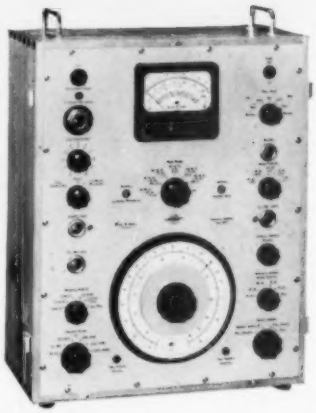

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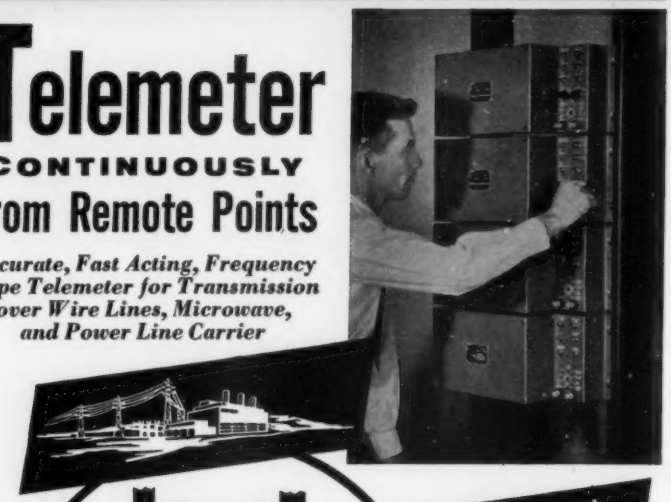

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The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, or other transducers with a DC mv output, to an output of 10 to 30 cps. If multi-channel operation over a single communication circuit is required, the 10 to 30 cps signal is used to modulate a built-in frequency shift tone channel. The Model 1090 Telemeter Receiver detects and demodulates the transmitted signal and generates a DC current or voltage which varies in exact accordance with the telemetered functions. The receiver output may be directly applied to either recorders, indicating instruments, or both.

The equipment is conservatively designed for continuous duty operation. The over-all accuracy of the Telemeter is 1% with a speed of response of one second.

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New instruments—cont.

Tachometer uses tuned circuit 141

Wilbac model 424 Tachometer consists of a miniaturized transistor radio set tuned to receive the ignition pulses radiated by internal combustion engines. Pulses are received, amplified and fed into a computer circuit that counts them and then displays the answer as rpm on a meter dial. No electrical connection to the engine is necessary since the meter

picks up radiated pulses on its built-in antenna. Two scales are provided: 0-1200 rpm for 8 cylinder motors and 0-1600 rpm for 6 cylinder motors. Simple multiplication of the scale reading enables the rpm of single, twin or four cylinder motors to be obtained.

Bach-Simpson Ltd., London, Ont.

Meter measures distance 142

Wayne Kerr distance meter type DM-100 affords a rapid and direct means of measuring distance in precision grinding processes, measurement of expansion, and other applications. It provides readings accurate to ±2% of full scale scale deflection.

The instrument operates in conjunction with non-contacting probes to provide a basically linear method of measuring distance from 50 microinches to ½ inch. Distance is read directly from a moving-coil meter, the full scale range depending upon the probe in use. Four probes are available for full-scale ranges of 1, 10, 100 and 500 thousandths of an inch.

The Glendon Instrument Co. Ltd., Scarborough, Ont.

Very low frequency generator 143

Compagnie des Computeurs model TBF-GP 64 generator is designed to provide signals from 500 cps down to 0.005 cps. Provides a stable sine wave, square wave, or saw-tooth output, and a synchronizing output signal is also available. Frequency ranges vary in the ratio of 1:10, hence only one scale is necessary. The output is across 100 ohms, balanced to ground, and 40 volts peak to peak is available. The stability of the output signal for line voltage changes of ±10% is 0.2 db with regard to level and 0.5% with regard to frequency.

Tellurometer Canada Ltd., Ottawa.

Random noise generator 144

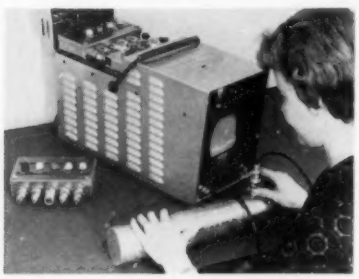
Random noise generator type 1390-B is capable of generating wide-band noise of a uniform spectral level. As a noise source it is useful for measurement of loudspeakers, intermodulation and cross talk tests on multi channel communication systems, simulating pulse noise in telephone line tests, noise interference tests, etc. With suitable amplification, this instrument can drive shake tables for vibration testing and loud speakers to produce high density sound field tests.

A gas-discharge tube (6D4) is used as a noise source; a magnetic field, applied to the tube, serves to eliminate oscillations usually associated with a gas discharge. Noise output is amplified in a two stage amplifier, which features noise-spectrum shaping filters controlled by a three-stage front-panel switch. The 20 kc setting introduces a low pass filter providing a gradual roll-off above 30 kc, the 500 kc setting inserts a low-pass filter that rolls off above 500 kc, and in the 5 mc setting is a peaking network that compensates for the drop in noise output from the gas tube at high frequency, so that a good spectrum can be obtained at 5 mc.

General Radio Co., Toronto.

Ultrasonic flaw alarms 145

Three new flaw alarms for electronic monitoring are now available as accessories for Sonoray ultrasonic pulse-echo flaw detectors built by Branson Instruments, Inc. Test signals which appear within preset limits are detected by the flaw alarm to actuate recorders or warning devices. Also, the alarm signal may be used to initiate corrective action automatically.



Models A, B, and C have two outputs in common: first is a red defect-indicator light mounted on the front panel, and the other is a 5 vdc signal for triggering external alarms for corrective action equipment. Model B also has a variable dc output, proportional to the size of flaw and the signal in the alarm gate of the crt. For high speed scanning model C permits recording flaws at the pulse repetition rate variable from 100 to 600 pulses per second (from 200 to 1000 on special order).

Electrodesign, Montreal; Magnachem Ltd., Vancouver.

(Continued on page 70)

Measures 1 mv to 1000 v from 15 cps to 6 mc

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Model 314

gives you these advantages:

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For your library

Text contains latest theorems on linear network analysis

Linear Network Analysis

Seshu and Balabanian; John Wiley & Sons, Inc., New York; 571 pp; $11.75.

Reviewed by W. G. Hoyle, Radio and Electrical Engineering Division, National Research Council, Ottawa.

The book is written for students at the first year post-graduate level. The first five chapters cover subjects usually found in undergraduate courses. It would be a mistake to consider them a review. The treatment is painstaking, detailed and precise; it will not appeal to an average student. However since the book is aimed at the post-graduate level, it is not intended for the average student. The detailed treatment makes the book an excellent one for self-study. Note for example on page 134 the careful definitions of the four possible transfer functions. Too many authors talk glibly about the transfer function, as though every one knew which one, or combination, was meant. A student particularly may waste a lot of time on such matters. I would have liked to see some mention of Shekel's "indefinite admittance matrix" and its uses. If answers to some of the numerous problems had been included the book would have been even more suitable for self-study.

If classical network analysis is considered to cover transient analysis plus steady - state - cisoidal analysis, then Chapter 6 marks the beginning of the modern approach. Here the basis of the convolution theorem, its relationship to impulse and step responses, and other inter - relationships with the Duhmel integral and the superposition theorem are carefully explained and illustrated. In the numerical example of convolution by the time series method, advantage could have been taken of this opportunity to include bandwidth-limited functions and their relationship to the series interval.

There is a chapter on network function theory, including a rather brief treatment of the pole-zero representation. The work of Bode, or rather as much of it as it is suitable, is included and carefully explained, including relationships between amplitude and phase, and the importance of minimum phase networks. Problems of computation of various functions are considered and explained with diagrams where needed. The poles are incorrectly located in fig. 4 (b) p. 233, but the book is generally free from such slips. (There is another in eq. (14) p. 411.)

Chapter 8 treats two-port networks, showing their derivation from the equations of a general network, and showing also the various forms into which the parameters can be transformed (z, y, T, h and g parameters). The scattering parameters are also covered. The question of interconnection of two ports is discussed and its importance in practical applications stressed. Tests for valid interconnections are given. Careful attention to student difficulties is evident, probably the natural result of classroom use of the book while in manuscript form. One lack is a simple explanation of the mathematical legerdemain by which a four-terminal network, requiring three equations, is treated as a two-terminal pair, or two-port, with two equations. An equation of constraint exists, of course, but in various forms; one form that students grasp readily is the requirement that the current into one terminal of a pair should be equal to the current out of the other. It is the validity of this equation of constraint, after interconnection, which is checked by the tests described.

Section 9 (Analytic Properties of Network Functions) is at a more advanced level than the earlier part of the book. It covers quadratic forms, energy considerations, positive real and reactance functions, RL and RC and open- and short-circuit functions, and finishes with topological formulas. It is well done, with the same painstaking care evident throughout the book. However, by now the range of the book is getting beyond what could be covered in a single year — or perhaps students work harder than they did.

The section dealing with feedback teaches first the basic concepts and vocabulary, then enough of the theory to enable a student to apply his knowledge of active network analysis to feedback problems. It does this much very well and it is doubtful if more could be done in space assigned. Included is a description of signal flow graphs, rather novel for a book of this type. It is excellent as might be expected, the subject being a specialty of one of the authors. It could mark a step forward in our network analysis techniques. It will be interesting to see

how students take to it. I regret to see no mention of the controversial work of Kron, though his name does appear in one of the problems. Also in a section on feedback, particularly where there is a widespread use of matrices as here, some mention should be made of Honnell's transmission matrix stability criterion.

The book concludes with a good section on classical filter theory. There are twelve appendices, including one on the Bromwich - Wagner integral, called here the complex inversion integral. This latter should help to dispel the notion that transforms have their origin in the Laplace integral, and should also make evident that the transform procedure is a two - way street.

In sum, the book is an excellent one for the post-graduate student who will, presumably, be an above-average student. It will appeal to those who want to have things understood rather than just to have them done and is particularly suited to self-study, save for the lack of question answers. Because it is basically a teaching textbook, it is not too suitable as a reference book. There is a selected bibliography and a good index.

Fundamentals of Electronics
Second Edition

E. Norman Lurch; John Wiley & Sons, Inc., N.Y.; 631 pp; $8.25.

Reviewed by E. L. Kerridge, Electronic Technology Dept., Ryerson Institute of Technology, Toronto.

"Fundamentals of Electronics" is likely the best attempt yet to produce a text to fill the gap between the trade and pure engineering levels, requiring only High School Algebra and Trigonometry as a prerequisite. Certainly it is very comprehensive and yet has avoided the popular tendency to give a smattering of every subject from Industrial Electronics to Space Medicine.

Mr. Lurch logically develops both vacuum tubes and transistors simultaneously from an analysis of the individual devices through to their applications, expanding such associated areas as decibels and oscilloscopes. However, it seems that one hundred pages on feedback and oscillators might be out of proportion to the eight pages on R.F. and I.F. amplifiers and no mention of wideband amplifiers.

The author has made an excellent attempt to give equal importance to both vacuum tubes and transistors. However, the reader is likely to receive a somewhat distorted picture of the chronological order when he reads "The conventional vacuum-tube amplifier may be thought of as equivalent to the grounded-emitter amplifier."

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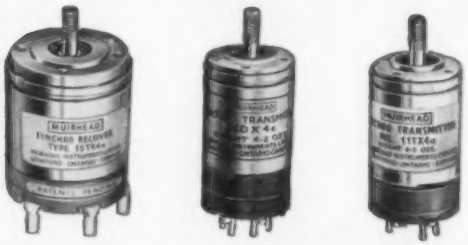

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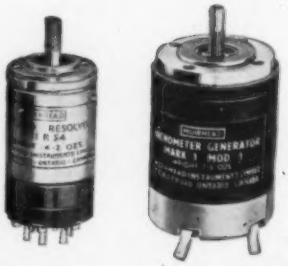

A concise index to all the types manufactured is available in the Muirhead Synchro Broad Sheet, which will be forwarded on request. Detailed information on individual types is also available in handy data sheet form.

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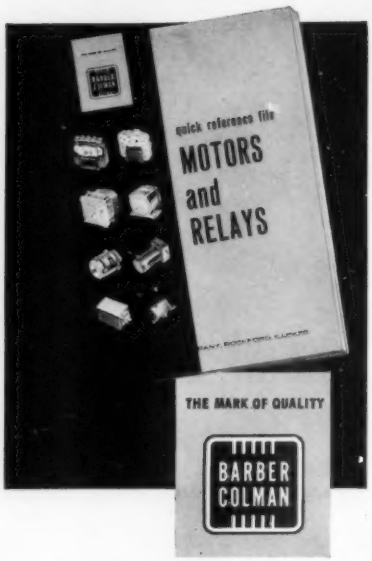

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New instruments—cont.

Differential voltmeter 146

John Fluke dc-ac differential voltmeter model 803R has been designed for rack mounting. It has a standard cell reference and employs the differential measurement principle. This feature enables the operator to measure all input voltages and frequency range to a high degree of accuracy. Accuracy specifications are 0.05% of any input dc voltage from 0.1 volt to 500 volts and 0.1% from 0 to 0.1 volt. For ac measurements over the 30-5000 cps frequency range from 0.5 to 500 volts, the accuracy is 0.2% of the input voltage. The instrument is usable on ac to 5 megavolts.

Allan Crawford Associates, Willowdale, Ont.

Stable frequency standard 147

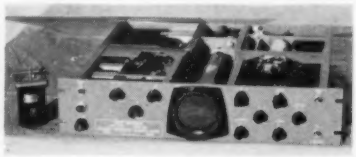
Hewlett-Packard model 100ER frequency standard provides a stability of $5/10^{8}$ parts per week and $3/10^{8}$ over short intervals. It offers a wide variety of output signals including six sinusoidal frequencies (10 cps, 100 cps, 1 kc, 10 kc, 100 kc and 1 mc) and 4 pulse signals (10 cps, 100 cps, 1 kc and 10 kc).

The frequency standard includes a timing comb for calibrating, and for measurement of sweeps and time intervals. It also has a built-in oscilloscope for Lissajous comparisons. Rated load of the instrument is 50 ohms at 1 mc and 100 kc, and 5000 ohms at the lower frequencies.

Atlas Instrument Corp. Ltd., Toronto.

Phase comparator 148

Phase comparator model VO-LF1 provides for the visual comparison of two electrical signals between dc and 50 kc. Reference signal is normally obtained from a crystal controlled oscillator, or the power line. Comparison signal is normally generated by the device under observation. Lissajous patterns are displayed on the built-in CRT and a horizontal input phase shift network control is incorporated in the comparator. Other features are: two



electronically stabilized power supplies and one high voltage rf power supply module; horizontal sensitivity of 0.125 mv/cm; vertical sensitivity of 3.3 mv/cm; amplifiers operating from dc to 50 kc with preaged and paired tubes.

Presentey Engineering Products Ltd., Ottawa.

(Continued on page 72)

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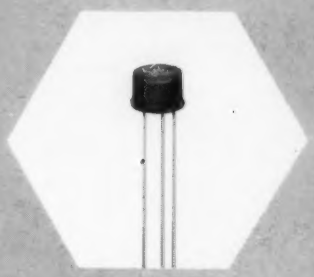

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Defence contracts

Unclassified electronics contracts for $10,000 or more have been awarded to the following Canadian firms by the Department of Defence Production. A figure in parentheses indicates the number of contracts, the amount being the total value.

December 16-31, 1959

- Aviation Electric Ltd., Montreal, aircraft instruments, $205,948; wind indicating equipment, $35,042; aircraft components, $33,426.
- Bell Telephone Co. of Canada, Montreal, installation and rental of communications facilities, $61,940.
- Bogue Electric of Canada Ltd., Ottawa, equipment, $38,625.
- Canadian Aviation Electronics Ltd., Montreal, mobile test equipment laboratory, $128,227.
- Canadian General Electric Co. Ltd., Toronto, fire control equipment, $90,000 (3).
- Canadian Marconi Co., Montreal, tubes, $454,545.
- Canadian Motorola Electronics Ltd., Toronto, mobile radio sets, $65,377.
- Canadian Pacific Railway Co., Ottawa, rental of teletype facilities, $27,123.
- Canadian Westinghouse Co. Ltd., Hamilton, technical services, $14,621.
- Collins Radio Co. of Canada Ltd., Toronto, technical services, $31,511; components, $84,654.
- Computing Devices of Canada Ltd., Ottawa, equipment, $98,447; rental of radio navigation equipment, $21,207.
- Edo (Canada) Ltd., Cornwall, Ont., technical services, $45,000.
- H. Roy Gray Ltd., Toronto, frequency meters, $11,386.
- Honeywell Controls Ltd., Leaside, Ont., aircraft components, $37,368.
- Picker X-Ray Engineering Ltd., Montreal, medical X-ray equipment, $22,384.
- Sperry Gyroscope Co. of Canada Ltd., Montreal, equipment, $267,226.
- Technical Enterprises Ltd., Malton, Ont., antenna supports, $10,828.

January 1-15, 1960

- Ampex American Corp., Ottawa, equipment, $19,634.
- Canadian General Electric Co. Ltd., Toronto, tubes, $33,806.
- Canadian Marconi Co., Toronto, tubes, $18,630.
- Canadian Westinghouse Co. Ltd., Hamilton, technical services, $50,000; tubes, $45,480.
- Collins Radio Co. of Canada Ltd., Toronto, equipment, $66,953 (2).
- Mel Sales Ltd., Toronto, radar test sets, $20,750.
- Northern Electric Co. Ltd., Ottawa, airborne equipment, $5,472,776 (2).
- Sperry Gyroscope Co. of Canada Ltd., Montreal, technical study, $84,027.
- Welwyn Canada Ltd., London, Ont., establishment of qualified source for the manufacture of computor resistors, $49,986.

January 16-31, 1960

- Aviation Electric Ltd., Montreal, accelerometers, $176,000.
- Canadian General Electric Co. Ltd., Toronto, components, $19,642.
- Canadian Westinghouse Co. Ltd., Hamilton, technical services, $22,000.
- Canadian Westinghouse Co. Ltd., Ottawa, tubes, $52,440 (2).
- Carriere & MacFeeters Ltd., Toronto, repair and overhaul of aircraft instruments. $110,000.
- Honeywell Controls Ltd., Leaside, Ont., aircraft instruments, $33,168.
- TMC (Canada) Ltd., Ottawa, equipment, $36,754.
- Varian Associates of Canada Ltd., Georgetown, Ont., tubes, $20,800.

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Correction

The following words were omitted from page 43 of the February issue:

" . . . megawatts. The Data Logger in this case consists of two identical Scanner-Loggers, one for each plant. These regularly make 44 entries on each typewriter and each includes an additional 59 bearing temperatures in the alarm scanning sequence. These latter are only printed when alarm conditions exist or when an individual temperature is requested by the operator. Since there are no headings on the log sheet for such entries, they are identified by a . . . "

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New equipment—cont.

Strain gauge power supplies 149

Series 200 (adjustable ±1 volt) and series 300 (continuously adjustable) transistorized strain gauge power supplies have been designed for use in any system requiring dc power from an ac source. They are available with output from 0 to 30 vdc. Input requirements are 117 volts (95-135), 60 cps, and they will operate over a range of +10 to +140 F. Each channel is independently fused and internal impedence is 0.02 ohms to 15 volts and 0.04 ohms to 30 volts dc.

Computer Engineering Associates, Inc., Pasadena, Calif.

Operates computers repetitively 150

High speed repetitive operation is now available as an accessory for all PACE 231R analog computers. This feature provides the operator with means of solving a variety of engineering problems that would be difficult through "real time" techniques alone. To obtain an optimum design in a problem with several variables, a great many problem runs are required. These are normally drawn on automatic recorders where speeds are limited by the mechanical characteristics of the recorders. With repetitive operation, the solution appears as a continuous plot on the 17-in. display screen. The effect of a change in the problem variables can be observed immediately on the display screen, without the necessity of resetting the equipment and drawing additional plots. When the optimum design is reached, the computer may be switched back to real time operation so permanent plots can be made of the final and more detailed solution.

The display unit consists of four chassis units mounted in a single bay rack and allows simultaneous viewing of eight problem variables plotted against time, or seven variables plotted against an eighth on the 17-in. screen. In the display unit, 21 voltage calibration lines are referenced to computer voltage within 0.1%. Time lines are generated by a crystal oscillator accurate to 0.05%.

Electronic Associates, Inc., Long Branch, N.J.

Laboratory magnetic tape recorder 151

The FR-100B precision magnetic tape recorder is designed for the storage, transfer and processing of a variety of data for business, military, industrial and scientific applications.

Developed from the Ampex FR-100 and FR-100A, the new machine has been produced to fill an urgent need for more diversified recording capabilities and versatile applications in laboratory-type recorders in its price range.

The FR-100B features a plug-in modular design which allows accessibility of all electronic components and sub-assemblies; the plug-in amplifiers are interchangeable. It uses a precision plate casting to which all other tape guiding elements are referenced.

A single equipment can record up to 14-tracks of direct fm or pdm data or up to 32 tracks of serial or parallel digital data. Six speeds ranging from 60 to 1⅞ ips are available on the standard equipment, electrically switchable in two overlapping ranges using a four position switch and a sample belt change. Broader speed ranges can be incorporated into the tape transport as required.

Ampex of Canada Ltd., Instrumentation Div., Ottawa.

Two-way voice repeater 152

Model 205A2 transistorized repeater, manufactured by Macson, Inc., is a two-way repeater for operation from 24 or 48 volts. Designed for cable and open wire use with a flat response from 200 to 3,500 cps, the complete unit takes only 1¾ in. of rack space. It is used with external repeat coils and can optionally be used as a four-wire termination set with amplifiers. Each repeater is a plug-in self-contained unit.

Tele-Radio Systems Ltd., Toronto.

Picture freezer 153

Hughes storage monitor will freeze video pictures instantly and hold the frozen image on the screen for as long as 10 minutes. The monitor is equipped with a 5 inch Tonotron tube which can display a continuous television picture and freeze the action at any desired time.

It can be connected directly to a closed circuit television camera, video tape recorder or other video signal source. It will monitor the picture until the store switch is manually or automatically actuated. This instantly freezes the action until normal picture action is again started by using the monitor switch. Applications include video tape editing, closed circuit tv surveillance, quick determination of action in sporting events, etc., storing of images where short burst fluoroscopic x-ray techniques are used.

R-O-R Associates, Ltd., Don Mills, Ont.

Industrial tv camera 154

Dage model 70-A tv camera has been designed for heavy duty industrial use as well as general closed-circuit applications. It features a transistorized video amplifier which eliminates microphones and provides 600-line resolution. Electronic circuits automatically make adjustments to variations in light levels. Other features include: on-chassis controls to regulate horizontal and vertical size, linearity and centering; adjustments for beam and black level. Power requirements are 45 watts, 115 v, 60 cps.

Model 70-AR has the added function of remote control optical focusing.

Thompson Products Ltd., Electronics Division, St. Catharines, Ont.

Power supply module 155

High voltage rf power supply module model RH-1 has an output adjustable to 5 kv at 0.6 ma. Input is 300 volts at 25 ma and 6.3 volts at 0.45 ma. It measures 3.5 x 3.75 x 4.25 in. and is supplied in a completely enclosed metal case with copper-mesh dust protected vent holes.

Presentey Engineering Products Ltd., Ottawa.

Machine tests memory systems 156

Memory exerciser type 1513 will automatically test coincident current core memory systems with planes up to 128 x 128. Detects and counts defective cores that are either dropping a "one" or picking up an extra "one". The exerciser provides a variety of checkerboard patterns to facilitate operation under worst case noise conditions. Its variable timing cycle is capable of operating down to 7 usec. The machine can be arranged to program in various cycles and indicate faulty cores located.

Digital Equipment Corp., Maynard, Mass.

(Continued on page 74)

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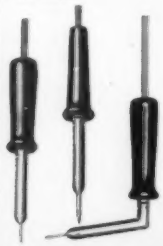

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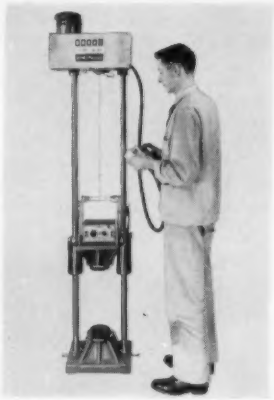
Other products — cont.

Shock testing machine 157

Barry Controls Inc. model 16750 Varipulse shock machine has been designed for production and laboratory testing of small electronic electromechanical and mechanical components. It accommodates test specimens weighing up to twenty pounds and occupying an eight-inch cube. It provides accurate and repeatable half-sine, saw-tooth, and square waves. For simplicity, economy of operation, and minimum maintenance, Model 16750 utilizes the gravity free-fall principle. A remote push-button control and a disconnect interlock provide safety features for the operator.



Model 16750 requires only a 110-volt power source, stands 7 feet 3 inches high and occupies a floor space 12 x 16 inches.

Samuel C. Hooker (Canada) Ltd., Montreal.

Controlled atmosphere welder 158

Designed for welding semiconductors and other small electronic parts under controlled atmosphere conditions, the new Precision C-type magnetic force welding gun fits easily into standard dry boxes. All air, water, and electrical supply lines are carried to the electrodes inside a hollow C-frame. This design leaves a minimum of area for sealing to dry box walls. The welding unit develops 2,200 lbs. weld pressure and accommodates transistor assemblies having a ring projection diameter up to approximately 1.25 inches. The electrodes can be changed without getting water in the dry box.

Precision Welder and Flexopress (Canada) Ltd., Toronto. END

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The Starkit Model VMK-2 vacuum tube voltmeter is an indispensable in TV, FM receiver servicing. It is particularly a must when circuit loading cannot be tolerated, and can be used as DC, AC RMS, AC Peak to Peak Meter and as an electronic ohmmeter, the VMK-2 permits unusual accuracy. Incorporates an attractive 6 inch clear view meter and proven printed circuit.

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Model 1001 Multi-Range VOM

The Starkit Model 1001 is a combination Volt-Ohm milliammeter, capacity, reactance, inductance and decibel meter, it also tests selenium and silicon rectifiers, silicon and germanium diodes. Housed in an attractive case and has an extra large 6 inch clear view multi-color meter.

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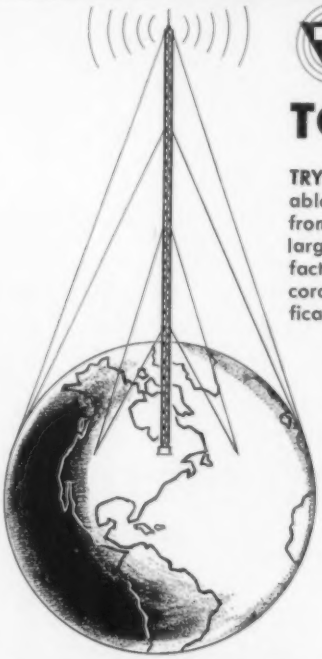

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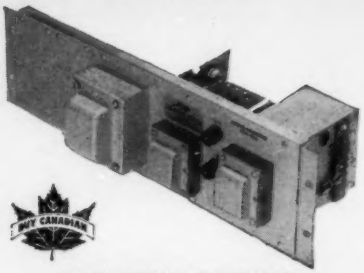

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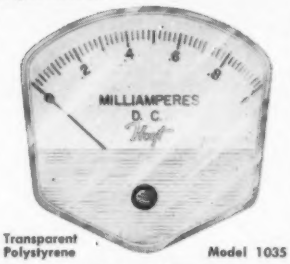

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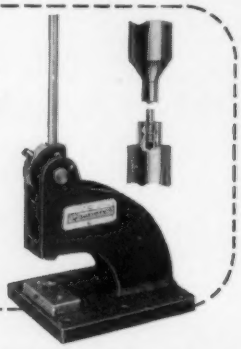

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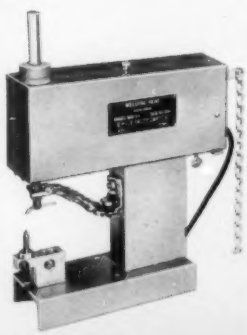

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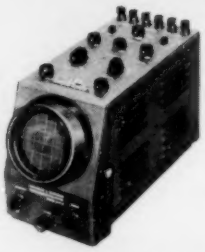

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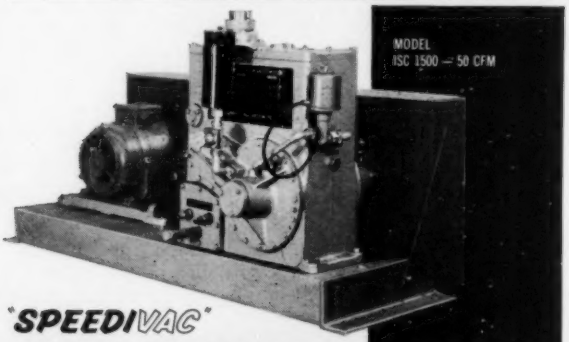

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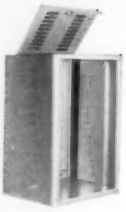

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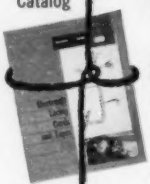

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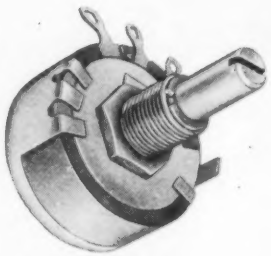

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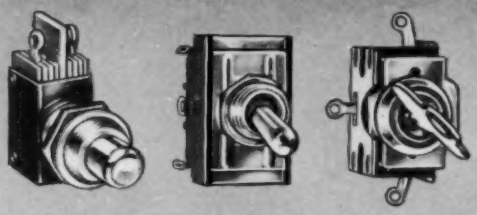

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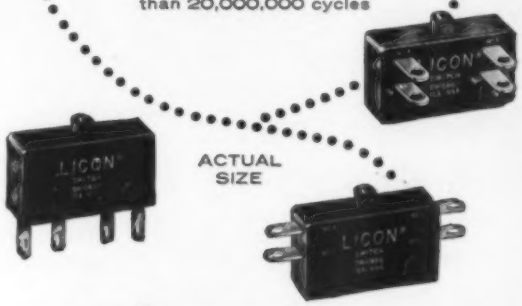

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". . . a toast to an organization that is unique in its undertaking of a program of practical research" — E. Hemphill, Editor, Canadian Aviation.

"An interesting measure of our growth is a 40-fold increase in financial activity"— Henderson, treasurer.

"We hope to see closer ties between groups in Canada with interests in astronautics"— Lapp, president.

"Patterns can be detected in all systems from sub-atomic to galactic"—Leaver, guest speaker.

Society strives for co-operation among astronautical groups

Canada's aircraft industry has suffered some severe blows during the past year and a half, but it has not reduced the faith many engineers have in the future of astronautics. At the second annual dinner of the Canadian Astronautical Society, members — reduced in number from last year — displayed an amazing amount of confidence in the future that Canada will play in astronautics.

The society is unique in its approach to practical research projects. Members have donated many hours of their time to Project Charm, a small, high altitude research rocket, that may be fired from the Fort Churchill range later this year. Preliminary tests have been undertaken in preparation for the final design of the rocket.

Speaking at the meeting, president P. Lapp expressed the hope that, in the years ahead, the various groups in Canada with interests in astronautics would come together to provide strong leadership for Canada in this field.

The guest speaker at the dinner was E. W. Leaver, president of Electronic Associates Ltd. His subject "Patterns in time and space" provided a lot of food-for-thought in a field that is very new.

Wholesaler's convention

The fifth annual national meeting of the Canadian Electronic Wholesalers' Association will be held at the Queen Elizabeth Hotel, Montreal, April 25-27. Business sessions will be held on all three days. Tuesday afternoon and evening have been set aside for a "Questions and answers" seminar, which will have a panel moderated by D. L. Harris of Atlas Radio Corp. The annual banquet will be held Tuesday evening.

A conducted tour of the RCA Victor Co. tube plant is scheduled for Monday morning. Plans are also being made for a tour of the Sun Life Assurance Co. of Canada electronic data processing centre.

Preceding the national meeting, the Eastern and Western divisions will hold their meetings, the former in Montreal and the latter in Edmonton on April 19, to elect divisional officers and to nominate three members from each division to constitute the board of directors for the new fiscal year.

Design Show

The Department of Trade and Commerce is entering an electronics section in the Design Show being held in New York, May 23-26. This will feature electronic products that can be used by design engineers in their work. Anyone interested in further details should contact Mr. D. L. Draper, Engineering and Equipment Div., Foreign Trade Service, Department of Trade and Commerce, Ottawa.

COMING EVENTS

March

7 Toronto Section IRE annual stag night, Four Winds, Toronto.

21-24 IRE International Convention and Radio Engineering Show, New York.

April

4-8 6th Nuclear Congress, N.Y. Coliseum, New York.

5-9 9th Electrical Engineers Exhibition, Earls Court, London.

12-27 Milan International Trade Fair, Milan, Italy. (Information from Italian Trade Commissioner, Suite 403, 34 King St. East, Toronto.

21-22 Seventh Annual Convention of the Society of Technical Writers and Editors, meeting jointly with the Technical Publishing Society, Drake Hotel, Chicago.

25-27 Fifth Annual National Meeting of the Canadian Electronic Wholesalers' Association, Queen Elizabeth Hotel, Montreal.

May

2-4 National Aeronautical Electronics Conference, Dayton, O.

Semiconductor alpha detectors

Scientists at the research laboratory of RCA Victor Co. Ltd., working in conjunction with government scientists, have produced a semiconductor alpha particle detector. Main feature in next month's issue will be a story on the new detector.

Looking for an inexpensive cold cathode trigger tube drive circuit for a decade counting tube? P. G. Hodgson of NRC describes one next month.

Two authors from the United Kingdom describe some of the problems and solutions of trans-Atlantic television transmission by undersea cable.

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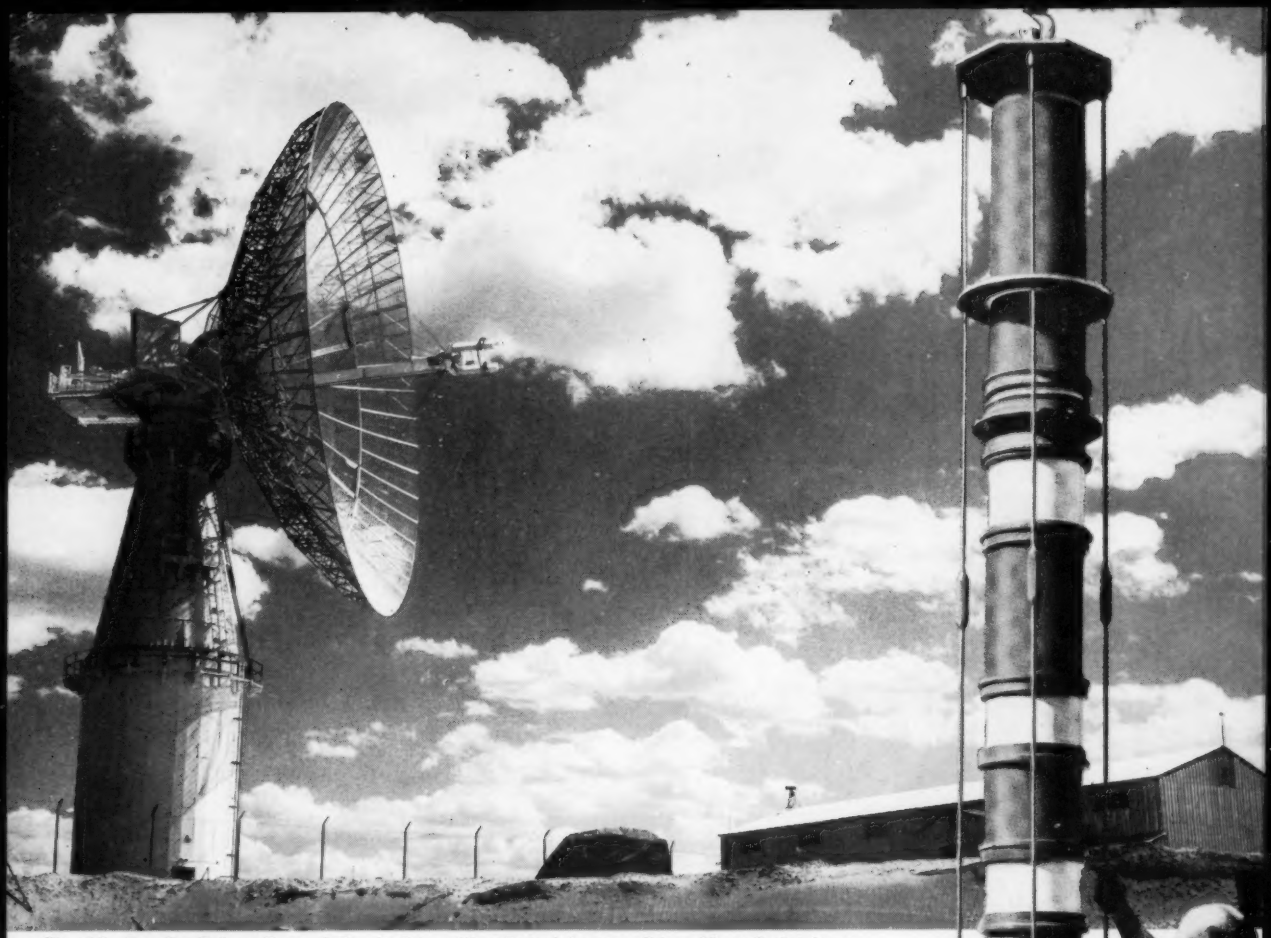

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